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ABSTRACT

This document reports on a 6-year study of science education reform, the Scope, Sequence, and Coordination (SS&C) Project. The reform included teacher enhancement activities as well as curricular materials and was designed to help science students achieve the National Research Council's Science Standards (1995). The two components of the study were comparing students who had participated in the reform movement with those who had not, and investigating the long-term effects of the reform movement. Results indicate that overall, the reform effort was successful in making changes in science instruction. Recommendations for effective implementation through teacher enhancement efforts and for longitudinal evaluations of teacher enhancement projects are also included. (Contains 24 references and appendices with data tables.) (YDS)

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Evaluating the Long Term Effects of Teacher Enhancement

February, 2001

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EXECUTIVE SUMMARY

This is the culminating report of an in-depth, six-year study of science education reform. The reform included teacher enhancement activities as well as curricular materials and was designed to help science students achieve the National Research Council's Science Standards (NRC, 1995). The longitudinal evaluation project was quite complex, used several data gathering methods and sources, and produced several reports and articles. The evaluation effort had two major components. The first component was designed to compare students who had participated in the reform effort with students from the same site who had not participated in the reform. The second component was to follow a subset of the sites to identify the long-term effects of the reform effort. For all six years of the evaluation effort both qualitative and quantitative data were gathered from principals, teachers and students through extensive site visits and assessment of student outcomes. The purpose of this report is to summarize and condense the findings from the subset sites. It presents the data gathered throughout the course of the evaluation effort by discussing the data from all of the sites as a set and by providing detailed information about each site individually. Furthermore the data are synthesized into a theoretical model for teacher enhancement and curricular implementation, and recommendations for future implementation and evaluation efforts are provided.

Cross Site Results

The classroom environments in the five schools changed significantly during the reform effort. There was more inquiry and more hands-on activity. After the funded reform effort ended, the classroom environments at the sites changed in different ways depending on the local context for the reform. Some sites continued or modified the changes while others moved back into more traditional methods. Consolidated impressions across the sites show that the sites were quite unique. The culture of each site interacted with the reform effort and played a significant role in the continuation, modification or regression of the reform. The culture of the site included several elements, such as the attitudes of the teachers toward change, the skills and philosophies of the teachers, the interactions of the teachers with the liaison teacher, the physical and emotional support available, the power structures within the school and external pressures, e.g., State or district mandates.

The continuing 9th grade data showed changes year to year in classroom learning environments, student attitudes and student achievement. There were substantial differences among the five sites. There appeared to be only a weak relationship between what occurred in the classroom and student achievement although there was also little stability in what occurred in the classroom. There was a weak relationship between use of inquiry or laboratory activities and student achievement as measured by lab skills performance tests. The students in the reform effort showed slightly greater achievement when they participated in the reform for two years in a row. These increases were maintained somewhat in sites that continued in reform mode.

The comparisons of the 12th grade students who had participated in the reform with those who had not showed that the non-reform students performed slightly better on the science literacy multiple choice test while the reform students performed slightly better on laboratory investigations. The students who participated in the reform had slightly better attitudes toward science. The comparisons of changes in the 9th and 12th grade cohorts of students who had participated in the reform and those that had not, showed no consistent trends in the changes from 9th to 12th grade.

The data showed that students with or without the reform were not achieving the standards at particularly high levels. Achievement on the science literacy multiple choice test was higher than on the more open-ended written items or on the extended laboratory investigation test. Planning controlled investigations appeared to be particularly difficult for the students. Students performed slightly better on planning investigations when they had equipment in front of them as opposed to when they imagined the experimental situation.

Overall it appears that the reform effort was successful in causing changes in the way science was taught. The initial appearance and persistence of these changes, however, were dependent on the different elements present at the sites. Some sites and individual teachers gained and retained more from the reform effort than others. The institutionalization of change in a school was greatly affected by external pressures, the power structures in the school in relation to the reform, the availability of support and the desire for change. The data showed that if the same teachers continued to teach the reformed curriculum and worked on adapting it to match with their environments, their students' achievement was more likely to be affected. Perhaps, as teachers become more experienced with reform, they become more comfortable teaching it, teach it more effectively, and convey clearer expectations for student performance.

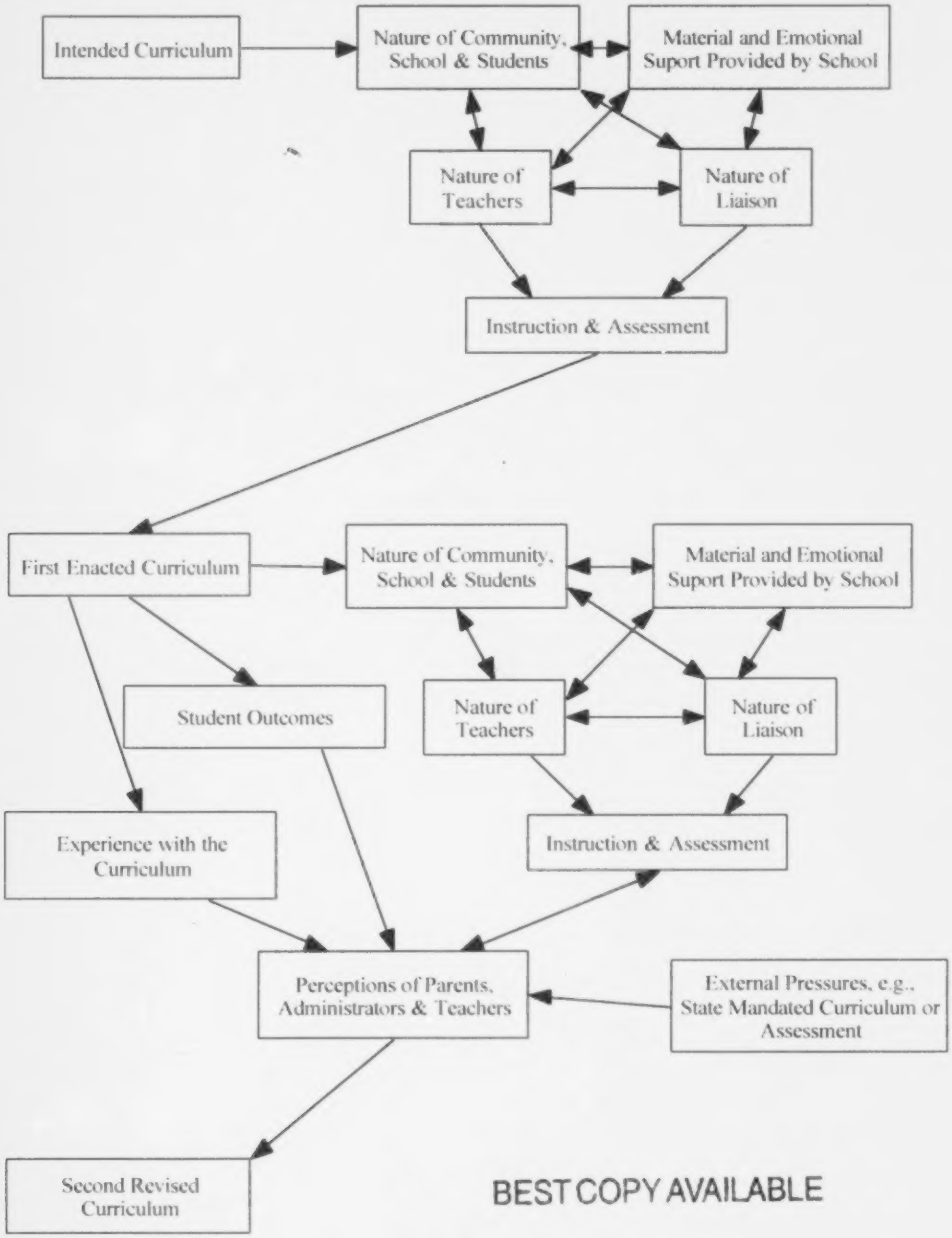
SS&C Model for Curricular Implementation

The model for curricular implementation in Figure A was distilled from the SS&C experience. It is based on the notion that the intended curriculum is filtered and modified by a variety of different contextual factors. In the case of SS&C, the original curricular materials developed by NSTA were intended to be consistently implemented in all 13 sites across the country. In reality each site modified materials based upon the unique features of their school.

The flow chart of curricular implementation in Figure A visually describes how the intended SS&C curriculum was first filtered through four inter-related factors: the community, the school and the students; the material and emotional support provided by the school; the teachers; and the liaison. Each site started with the materials developed by NSTA, but then considered how the materials could be used in their school with their own unique student population. The intended curriculum was also filtered through the support provided by the school and the existing resources available. The nature of the teachers, such as their content understanding, teaching philosophy, and openness to change, and of the liaison, such as his or her connections within the school power structure and facilitation skills, were also critical components of the curricular implementation. Ultimately, it was the teachers and the liaisons who made final decisions about the instruction and assessment that was used in the class.

This resulted in the first enacted SS&C curriculum. This enacted curriculum was once again filtered through the same factors; however, this time around student outcome data and experiences with the curriculum were available. The teachers, parents and administrators had perceptions about the effectiveness of SS&C and these perceptions served as another filter for the curriculum. External pressures also impacted the SS&C curriculum. State mandated curriculum and assessment modified the implementation of SS&C at some sites. The result of this second filtering process was the implementation of the second enacted SS&C curriculum. Theoretically, the process could continue into the future. Each year the curriculum is modified and reconsidered based upon student outcomes, the local context, and external pressures. The result is a cyclical curriculum implementation process that reconsiders and implements a modified curriculum each year.

Figure A: SS&C Model for Curricular Implementation


Intended Curriculum
Nature of Community, School & Students
Material and Emotional Suport Provided by School
Nature of Teachers
Nature of Liaison
Instruction & Assessment
First Enacted Curriculum
Nature of Community, School & Students
Material and Emotional Suport Provided by School
Student Outcomes
Nature of Teachers
Nature of Liaison
Experience with the Curriculum
Instruction & Assessment
Perceptions of Parents, Administrators & Teachers
External Pressures, e.g., State Mandated Curriculum or Assessment
Second Revised Curriculum

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Recommendations

Recommendations for Effective Implementation Through Teacher Enhancement Efforts

1. Recognize that each school and teacher is unique and that consequently each implementation will also be unique. A project-wide curriculum will be modified by individual sites.

2. Recognize that external pressures such as curricular and assessment requirements may significantly impact the new curricular implementation.

3. Obtain district commitment to continue the implementation for at least three years with most of the same teachers. Effective change takes time.

4. Obtain district commitment to provide the necessary facilities and materials as well as support a process for making the materials easily accessible.

5. Involve teachers who either want to make a change or who are willing to try it and withhold judgment until later. Do not force the change on the teachers.

6. Have small groups of the teachers who will be directly involved in the implementation attend training.

7. Involve teachers in the development of the curriculum materials to help develop ownership and to help guarantee ease of implementation, but do not expect teachers to write the curriculum per se. The support of professional curriculum developers is needed in the initial stages of development.

8. Provide personally supportive, local liaison teachers who have the knowledge necessary to be effective guides and who are part of the power structure. They can give the implementing teachers access to power and provide official support and sanction for their efforts.

9. Gather and provide evidence to the teachers and schools that the changes are producing valuable effects.

10. Develop strong communication networks within and between sites, and between sites and the centralized project staff to increase teachers' feelings of involvement and ownership in the project. The need for consistent and formalized avenues of communication increases as the number of implementation sites increases.

Recommendations for Longitudinal Evaluations of Teacher Enhancement Projects

1. Use the school or classroom as the unit of analysis with quantitative data and/or employ HLM techniques.

2. Build rapport with the school and teachers to facilitate the data collection. Have a contact teacher in each school who can help evaluators meet data collection needs.

3. Carefully document everything that is done throughout the project and develop comprehensive filing systems that allow back-ups of all vital materials.

4. Select evaluation team members who will be able to continue to participate over the whole course for the study.

5. Bring new people in and out of the evaluation team to provide new insights and energy.

6. Have an external evaluation consultant to the evaluation effort who can review and refine the evaluation approaches.

7. Produce publications or reports as the project progresses. These reports could be on

the main topic or involve more research-oriented special questions or interpretations about the data being collected.

8. Include sufficient funding for strong clerical help in formatting reports, tracking data, editing, and numerous other administrative tasks.

9. Be vigilant in the data analysis. Conduct routine crosschecks of data analysis procedures. Have more than one-person conduct analyses to serve as a crosscheck. Doing "side" studies can help to identify weaknesses in the analyses.

I. INTRODUCTION

This is the culminating report of an in-depth, six-year study of science education reform. The reform included teacher enhancement activities as well as curricular materials and was designed to help science students achieve the National Research Council's Science Standards (NRC, 1995). The reform effort was the Scope, Sequence and Coordination Project (SS&C) and consisted of two summer workshops, school year contact, and curricular materials matched to the instructional philosophy presented at the workshops.

The evaluation effort had two major components. The first component was designed to contrast students who had participated in the reform efforts with students from the same site who had not participated in the reform. The second component was to follow a subset of the sites to identify the long-term effects of the reform effort. For the first three years data were gathered from all of the sites participating in the reform effort. For the next three years data were gathered from five of the original sites. For all six years both qualitative and quantitative data were gathered from principals, teachers and students. Student information included data from several different types of assessment measures in addition to questionnaires and interviews.

This report summarizes the data gathered throughout the course of the evaluation effort in four ways. First this report provides detailed, longitudinal descriptions of how teacher enhancement operated across the five continuously studied sites. Second, it provides a theoretical model for curricular implementation grounded in the data that were gathered. Third, this report provides recommendations for future teacher enhancement efforts and their evaluations based on insights gained through the data. Finally this report provides detailed, longitudinal descriptions of how teacher enhancement operated in each of the five sites.

Several other reports were produced as part of this evaluation effort. The initial report, *Scope, Sequence and Coordination: 9th Grade Science (October, 1996)* contrasts the classroom learning environments, student attitudes and student achievement for 9th grade students the years before and after the reform effort. This report also contains case studies of three teachers describing their perceptions of their participation in the reform. The second report, *Scope, Sequence and Coordination: 10th Grade Science (September, 1997)* provides information similar to the first report except it contains information on 10th graders. The pattern of detailed reports providing yearly in depth single and cross site, 9th grade information, for the five longitudinal sites was continued in two more reports: *Evaluating the Long Term Effects of Teacher Enhancement (January, 1999)* and *Evaluating the Long Term Effects of Teacher Enhancement (June, 2000)*.

Another report, The Supplementary Evaluation Report, *Scope, Sequence and Coordination: 9th and 10th Grade Science (December, 1997)* provides a comparison of the results for the 9th and 10th graders and information on students who participated in the reform effort in both 9th and 10th grade. This report shows that the students who participated in SS&C for two years were similar to all 10th grade students with a few differences favoring the two-year SS&C students. Students who had taken SS&C for two years were more likely to say they would take science in 12th grade, and they had higher scores on physical science multiple choice items.

The original cohorts of 9th grade students were contacted again when they were in 12th grade and asked to respond to a subset of the original evaluation instruments. The results contrasting the two cohorts over time are presented in the report entitled, *Evaluating the Long Term Effects of Teacher Enhancement: 9th and 12th Grade Comparison (August, 2000)*. This report shows mixed results. Ten of the sixteen differences found in student motivation, participation in science activities outside of class, and attitudes toward science favor the SS&C students. In terms of achievement the comparison group students outscored the SS&C students on the multiple choice, open-ended, and lab skills performance tests while the SS&C students outperformed the comparison group students in conducting hands-on full investigations.

In addition to the evaluation reports several journal articles and other publications were produced. These include:

1. Huffman, D., & Lawrenz, F. (in review). Reforming science education in urban schools. *Journal of Research in Science Teaching.*

2. Lawrenz, F. & Huffman, D. (in review). Relationships among student, teacher and observer perceptions of science classrooms and student achievement. *Educational Evaluation and Policy Analysis.*

3. Huffman, D. (in review). Evaluating science inquiry: A mixed-method approach. In J. Altschuld & D. Kumar (Eds.) Program Evaluation in Science Education The Netherlands: Kluwer.

4. Lawrenz, F., Huffman, D. & Welch, W. (in press). The science achievement of various sub-groups on alternative assessment. *Science Education.*

5. Huffman, D., Sinclair, M. & Lawrenz, F. (in press). The relationship between the science classroom learning environment and achievement among students with and without disabilities. *Journal for Elementary/Middle Level Science Teachers.*

6. Lawrenz, F., Huffman, D. & Welch, W. (2000). Policy considerations based on a cost analysis of alternative test formats in large scale science assessments. *Journal of Research in Science Teaching, 37(6)*, 615-626.

7. Huffman, D. & Lawrenz, F. (Fall, 1999). Achieving the science standards: A national study of inquiry-based instruction in high school science. In D. Huffman (Ed.), Research Practice (pp. 17-24). Center for Applied Research & Educational Improvement, University of Minnesota.

8. Welch, W., Lawrenz, F. & Huffman, D. (1998). The precision of data obtained in large scale science assessments: An investigation of bootstrapping and half-sample replication methods. *Journal of Research in Science Teaching*, 35(6), 697-704.

9. Huffman, D., Lawrenz, F. & Minger, M. (1997). Within-class analysis of ninth-grade science students' perceptions of the learning environment. *Journal of Research in Science Teaching*, 34(8), 791-804.

10. Aldridge, B., Lawrenz, F. & Huffman, D. (1997). Scope, Sequence & Coordination: Tracking the success of an innovative reform project. *The Science Teacher*, 64(1), 21-25.

11. Lawrenz, F. & Huffman, D. (1995). The SS&C project: Project evaluation and national science education standards. In D. Tulip & D. Smith (Eds.), Conference Proceedings of the Australian Science Teachers Association Queensland, Australia: Queensland University of Technology.

In addition to the information and charts presented in this report, an Appendix of Tables has been compiled. The Appendix contains tables that support each chart found in the report. The Appendix also contains additional tables, which provide more detail about specific results.

II. HISTORY

In order to understand the context of this evaluation project and the reform effort it investigates, it is important to know the history. The reform effort was built on a vision of science education developed by Bill Aldridge, former executive director of the National Science Teachers Association, and his associates. The vision was formed out of the concern for the United States' leadership in science and mathematics prompted by the international comparisons of student performance in mathematics and science. The vision was embodied in the title, "Scope, Sequence and Coordination." Scope meant that the studies should be rigorous. Sequence meant that the students should have experiences first and then tie these experiences to concepts. Coordination meant that each science was to be coordinated with the others, not presented one at a time. Although there was a middle school SS&C project, this report is about the high school project. The project was headed by Aldridge and controlled centrally with all sites using the same curriculum materials. The goal of the project was to improve student performance on the newly developed National Science Education Standards (NRC, 1995).

The Intervention

The National Science Teachers Association (NSTA) believed there was a need for a new coordinated approach to science education because so many students were underachieving in the sciences. A coordinated approach where every science is taught every year was advocated because so many students are systematically filtered out of the advanced sciences. Essentially, students identified at an early age as the "most able" are encouraged to take advanced science courses, while "less able" students take only the minimum amount of science. Over 50% of the students in the U.S. only take one year of high school science. Minority students, who tend to be predominately enrolled in urban schools, are even less likely to enroll in advanced science courses than other students (Mullis et al., 1994). There is a belief that other countries tend to educate the elite in the sciences, while the U.S. teaches to all students; however, in the sciences quite the opposite is true. The data suggest that the U.S. filters "low achieving" students out of the sciences. The NSTA believed that part of the reason students fail to pursue the sciences is that in the U.S. the curriculum tends to be "layer-caked." Typically, physical science is taught in 9th grade, biology in 10th grade, chemistry in 11th grade, and physics in 12th grade. Coupled with graduation requirements of only one or two years of high school science, this approach tends to lead to a less in-depth understanding of the sciences, especially in chemistry and physics. Most European and Asian countries, which also tend to score higher than the U.S. on international comparisons of science achievement, tend to use a coordinated approach to science where every science is taught every year. The NSTA sought to develop such a coordinated science program that would allow all students to study all sciences every year, instead of reserving advanced science for only advanced students.

The ultimate goal of the project was to help students achieve the National Science Education Standards (NRC, 1995). The NRC Science Education Standards were developed as guidelines for achieving science literacy for all students, and include concepts and skills that all students should achieve by the end of high school. Although the NRC Standards provide excellent guidelines for science teaching, they do not provide specific lessons or procedures for teachers, and they were not designed to be an implemented curriculum. Translating the Standards into actual classroom practice still remains to be accomplished. The NSTA project was one of the first comprehensive efforts designed to translate the Science Education Standards into actual classroom practice. It was essentially an inquiry-oriented science program designed to help all students achieve the science standards.

The basic tenets underlying the project were:

1) every student should study the four science subjects of biology, chemistry, physics and the earth/space sciences every year;
2) science teaching should take into account students' prior knowledge and experience;
3) students should be provided with a sequence of content from concrete experiences and descriptive expression to abstract symbolism and quantitative expression;
4) students should be provided with concrete experiences with science phenomena before the use of terminology that describes or represents those phenomena;
5) concepts, principles, and theories should be revisited at successively higher levels of abstraction;

6) learning should be coordinated in the four science subjects so as to interrelate basic concepts and principles;
7) teaching should utilize the short-term motivational power of relevance by connecting the science learned to subject areas outside of science, to the practical applications of how devices in our technology work, and to the challenge of solving those personal and societal problems that have relevant underlying scientific components;
8) teaching should utilize the long-term motivational power of sudden and profound understandings of science and of the awe which stems from comprehension of the power and universality of a relatively small number of fundamental principals of science;
9) coverage of topics should be greatly reduced with an increased emphasis on greater depth of understanding of those fewer fundamental topics;
10) assessment methods, items, and instruments to measure student skills, knowledge, understandings, and attitudes should be consistent with 1-9.

The NSTA project included both curriculum development and teacher enhancement. In fact, NSF jointly funded the project under both the Curriculum Development and Teacher Enhancement divisions. The curriculum was developed by bringing together high school teachers from around the country to design activities and learn how to implement the activities using an inquiry-oriented pedagogy as defined by the NRC National Science Education Standards. Site-based implementation teams were formed to actually implement the curriculum in the classroom, and follow-up workshops were held throughout the school year to work on modifications to the curriculum. The 9th grade curriculum was first implemented in the 1995-96 school year.

The SS&C project was designed to provide teacher enhancement and curricular materials through national workshops and committees. During the first year of the project the teachers were to develop, pilot test and revise lessons that fit the ten tenets of SS&C. These lessons were to serve as a basis for an intensive summer workshop where the teachers would be steeped in the SS&C philosophy and work as a development team in the finalization of the draft 9th grade SS&C curriculum. The idea was that this involvement in the development process would allow the teachers to construct a common meaning of the SS&C philosophy so that they would "own" it when they returned to their classrooms. The teachers were also members of various national committees, e.g., assessment, where they worked on specific ideas to be shared with the whole group. The plan was that the next year and summer would focus on the development of 10th grade, the next on 11th grade and finally in the fourth year 12th grade.

There were thirteen schools participating in the project originally. Two in North Carolina, three in Texas, three in California, two in Iowa and one each in Montana, New York and Washington, DC. Several of the States: California, Iowa, Texas, and North Carolina, had participated in the middle school project and were familiar with the philosophy of SS&C and had some infrastructures in place for support of the teachers. In these states local liaisons, generally affiliated with a local university, provided guidance to the teachers in the schools and offered workshops throughout the school year to further the teacher enhancement. All sites had within the school liaisons that helped other teachers on a one-on-one basis to implement SS&C.

After the first year and half, the continuation of the project was questioned. There were concerns about the cost of the project, the quality of the curricular materials and the ability to move the project into the 11th and 12th grades. NSF originally funded the project to develop only 9th and 10th grade materials. More funding was needed to develop 11th and 12th grade materials. There was no official word on continuation of funding until after the second summer workshop, so that workshop continued as planned. The purpose of the second summer workshop was to provide opportunity for enhancement for the 10th grade SS&C teachers. This included some of the teachers who had participated in the 9th grade instruction and enhancement as well as new teachers. After the summer workshop the project received word that it had not been funded to continue development into the 11th and 12th grades. There were some funds left to finish out the school year but after that the project would have to continue through the efforts of the individual sites. This was quite a blow to the participating schools, but since the school year was beginning and the curricular materials were ready, they went ahead with offering the 10th grade SS&C.

The longitudinal evaluation of SS&C was summative in nature. It was distinct from the reform effort in that it operated at a different site, was conducted by a different PI and had its own separate advisory committee. The evaluation used a multi-method, time lag, quasi-experimental design where the students in each school during the first year when the reform was not being implemented served as the comparison group for students in the subsequent years when the reform was implemented. In this way most of the contextual variables were controlled. The evaluation gathered data on three major outcomes: student achievement, student attitude and motivation for science, and classroom activities. Evaluation team members monitored classroom activities through observations, student and teacher questionnaires, and student, teacher and principal interviews. Student attitude and motivation were measured through questionnaire data. Student achievement was measured through the use of several different types of assessments. Students completed multiple choice items, open-ended items, laboratory stations and full scale experiments. Case studies of individual teachers were also conducted to shed light on their perceptions of the reform process.

The evaluation began as soon as SS&C was funded in order to gather comparison year data. Data the first year were collected from 9th grade students who had not participated in the reform. Data the second year were collected from 9th grade students who had participated in the reform and from 10th grade students who had not (the prior year 9th graders were re-tested). The news about the discontinuation of funding was obtained as the evaluation was preparing for the third year of data collection which would be to collect a second year of reform data from 9th graders and a first year of reform data from 10th graders. The evaluation continued mostly as planned for that year with remaining funds.

Because the evaluation results were informative and showed site based effects, the evaluation team felt that it would be important to continue their examination of the impact of the reform effort. Therefore the evaluation team proposed a new evaluation project that would examine the effects of the reform effort in a more longitudinal and process oriented fashion by following five of the original thirteen sites. The purpose of the evaluation was to better understand what happened to a major teacher enhancement effort over time. The same comprehensive data collection continued and was augmented by more in-depth interviews and more questions about the reform process. This extended evaluation project also gathered data from the students in 12th grade that had been tested in 9th and 10th grade.

III. DATA COLLECTION

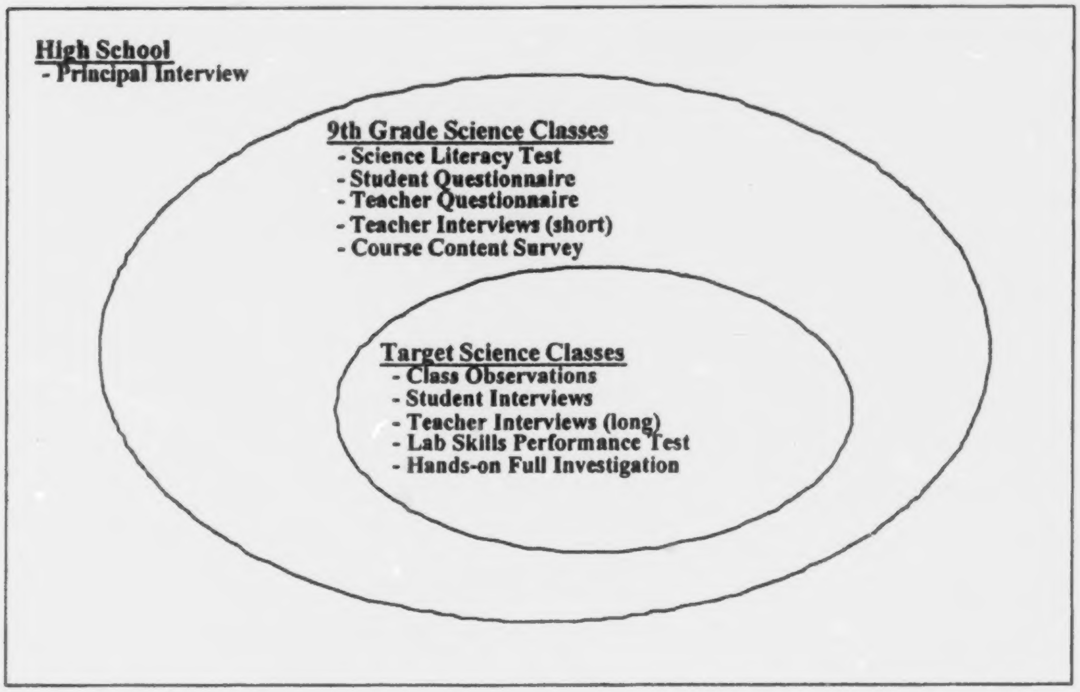
There were two phases of data collection. Phase one was for the first three years of the project and included thirteen schools, and phase two was for the last three years and included five schools. This report concentrates on the case studies of the five schools including data from all six years. A longitudinal, mixed-method case study approach was used. The study was mixed-method in that it attempted to integrate both case study and comparison approaches as described by Green and Caracelli (1997). The case studies purposefully included a mix of qualitative and quantitative data in order to examine the impact of the NSTA curriculum from multiple perspectives (Yin, 1994). The case study was comparative in nature, meaning that students in traditional science classes (the 9th grade students in the 1994-95 school year) were compared with students in subsequent years who used the new NSTA coordinated science approach (9th grade students in the 1996 – 2000 school years). In essence, it was a time-lag design where the prior year's science students were compared to each subsequent year's science students.

The continuing case study schools were chosen from the thirteen schools involved in the first three years of evaluation of SS&C. They were selected to be representative of the diversity in the U.S. in terms of geographic areas, population and race/ethnicity. The schools were located in California, Iowa, Montana, New York, and Texas. There were approximately 20 teachers teaching 9th grade science classes at these schools and over 1,500 students being taught by these teachers each year. Ninth grade science courses at these schools during the 1994-95 comparison school year had been quite diverse; some courses concentrated on a single science area such as physical science, life science or earth and space science, while other courses included various arrangements of the sciences such as integrated and coordinated science. Some courses were a year long and met everyday for 45 minutes, while other courses were only a semester long and met 90 minutes each day.

The evaluation team developed ten instruments. Because the study was based on the premise that the learning environment affects student achievement, both the learning environment and student achievement were assessed. Contextual variables were assessed using a student questionnaire, a teacher questionnaire, a classroom observation schedule, principal, teacher and student interview protocols, and a course content survey. Because the major measure of the effectiveness of the SS&C project was student achievement, it was examined from several different perspectives. Students participated in a five station hands-on laboratory skills test, answered multiple choice science content items, designed and conducted an experiment, and answered open-ended science content items. Standardized administration and scoring protocols were developed to ensure consistency and objectivity. Descriptions of all assessment instruments, the instrument development process, and the psychometric properties of the instruments are included in the *Evaluating the Long Term Effects of Teacher Enhancement (February, 2001) Appendix.*

A nested data collection design was used to gather information at each of the school sites. Data were collected from all participating 9th grade students and teachers. In addition, three 9th grade classes at each school were targeted for more comprehensive data collection. Except for the science literacy test and the course content survey, which were mailed to the schools near the end of the school year, the data were collected by the evaluation team during site visits. Site visits were conducted in the spring and fall during each of the six years of the study, except the fall of 1996. During the fall and spring visits, all 9th grade teachers were interviewed and the three target classes were observed. During the spring visit, in addition to the interviews and observations, most of the 9th grade students were given a questionnaire to complete. Those not taking the questionnaire were six to twelve of the students in each target class who were randomly selected to take the lab skills performance tests. One student from each target class was also interviewed. The school principal was interviewed only during the fall site visit. See Figure B for a schematic of the data collection instruments and sources of information.

Figure B: Data Collection Instruments and Sources of Information



In addition to collecting data from 9th grade teachers and students at the five schools for the entire six years, data were collected from 10th graders for two years (one comparison group and one SS&C group) and from 12th graders for two years (one comparison group and one SS&C group).

The data collection procedures and instruments for 10th grade data collection were identical to the procedures and instruments described above for the 9th grade. For the 12th grade data collection, the teacher interview, classroom observations, and course content survey forms were not used since 12th grade students were not all enrolled in science classes. 12th grade

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achievement assessment differed from 9th grade assessment as well: 12th grade students answered a shortened version of the science literacy test, designed and conducted one of three experiments and were not asked to answer any open-ended science content questions. Two reports, *Supplementary Evaluation Report, Scope, Sequence & Coordination: 9th and 10th Grade Science (December, 1997)* and *Evaluating the Long Term Effects of Teacher Enhancement, 9th and 12th Grade Comparison (August, 2000),* fully describe the data collection procedures and instruments used to collect these data.

The results of the tests and questionnaires were analyzed using the students as the unit of analysis. In evaluation reports of the first three years, the class was used as the unit of analysis because data from all 13 schools were combined and there were over 100 classes in the evaluation. The present study is a case study approach, and the data from each school are not combined. There were not enough classes at each school to analyze the data by class, and therefore the data were all analyzed using the student as the unit of analysis.

IV. CROSS SITE FINDINGS AND IMPRESSIONS

This section covers a variety of topics related to cross site findings over the six years of the study. First it presents brief summary information about the persistence of the reform in all of the 13 original sites. This is followed by capsule descriptions of the five case study sites. After these descriptions, consolidated cross site data about the five sites is presented in terms of learning environments, student attitudes and motivation, and student achievement. The section concludes with three different syntheses of the data: descriptive impressions, a diagrammatic model and recommendations. The consolidated cross site data is presented both textually and in charts. The charts in this section show trends over the six years of the study for each of the five followed sites. The data displayed in the charts are also presented in detail in the tables in the Appendix.

In this study, the scores on all of the measures administered in the years after the reform was implemented (1996, 1997, 1998, 1999, 2000) were contrasted with the scores on the measures in the comparison year (1995). The contrasts were conducted using various statistical tests, and p levels of .05 or less determined significance. Such changes are referred to as "statistically significant" or "significant" within the text. Additionally, each student outcome cross site chart has a corresponding effect size chart. Effect size is defined as the measure of the degree to which the mean of one population and the mean of another population differ in terms of the standard deviation of the parent population. Because of the large differences between the years, the standard deviation was calculated for each pair of years separately. The measure of standard deviation used was the " square root of the pooled variance" for the two years being compared for each instrument. This procedure best controlled for statistical bias and error. The formula used was: $d = \text{Mean1} - \text{Mean2} / \text{square root of pooled variance}_{\text{within group}}$ The effect size charts allow us to consider relative educational significance in addition to statistical significance. For the purposes of this report, an effect size of ± 0.5 was considered to be educationally significant (Howell, 1997).

Persistence of the Reform

Detailed descriptions of all 13 of the sites that initially participated in the teacher enhancement cannot be provided because only five of the original 13 were followed over time. However, in the spring of 2000, seven of the original eight sites that had not been followed were contacted to determine what aspects of the SS&C reform remained at their schools. The eighth school was not contacted because it had never really implemented SS&C. The researchers spoke with one teacher involved in SS&C at six of the seven schools that were contacted. One school did not have anyone remaining on staff that had been involved with SS&C. This information was combined with the data from the five case study sites to provide this snapshot of persistence of the reform.

At the time of the interview, three of the seven schools were no longer using any SS&C curricula or activities. Three schools were using modified SS&C activities and curricula, and one school was using only the earth and environmental science SS&C activities. Similarly, two of the five case study sites were still using the curriculum. One of the case study sites was using it in a significantly modified fashion, and two were not using it at all.

Level Of SS&C Curriculum Use After Five Years

Never Used	Stopped No More Use	Significant Modifications	Substantially Still Use
1	5	5	2

When asked what SS&C teaching techniques were still being used at their school, most of the seven non case study schools indicated their schools were using an activities based program, hands-on activities, inquiry-based science or an integrated approach. One school indicated they might be using SS&C activities and techniques but no faculty familiar with SS&C remained to identify them as such. Two of the teachers pointed out that their schools used SS&C teaching techniques but not as a result of being involved with SS&C. At the case study sites the two sites which had continued to use SS&C also continued to use SS&C teaching techniques, as did the site which had continued to use SS&C with modifications. One of the sites that was not using SS&C was using the techniques, but was using them because they had been in use before SS&C. At the remaining site only one teacher was using the techniques.

When asked about use of the type of assessment techniques recommended by SS&C three teachers reported that none were being used at their school. At the remaining four schools, one teacher indicated the teachers used portfolio assessment, fewer paper and pencil assessments and students made PowerPoint presentations. Another school used some performance assessment but used more objective testing than SS&C assessments. The teachers from the third and fourth schools said they used some of the SS&C assessment ideas. At the five case study sites, four were using some assessments of the type recommended by SS&C and one was not.

When discussing the SS&C philosophy that still remained at their schools, the teachers most often mentioned a commitment to hands-on learning. Two schools in one State reported being in support of integrating the curriculum but that the State had mandated that they do not integrate. Three teachers indicated that the integration philosophy remained. Two schools in another State reported that none of the SS&C philosophy remained, one citing that the textbook dictated philosophy and the other citing the complete turn over in science faculty at the school. The situation was similar at the five case study sites. The philosophy remained at the three sites using at least parts of the curriculum. One of the remaining sites had an inquiry-based philosophy before SS&C, and at the fifth site only one teacher retained any of the philosophy.

The Case Study Sites

The continuing contact with the five case study sites, including in-depth discussions with the participants and extensive data collection, provided rich sources for reflection on elements necessary for successful teacher enhancement. Because it is difficult to understand generalizations without any knowledge of the individual entities, capsule descriptions of each of the five sites are provided here. More detailed information is included in the by site sections of this report.

1. This Montana site was a large, mostly Caucasian junior high school in a fairly large rural city. The school had the necessary facilities and materials to support the curriculum and had few behavior or discipline problems. The 9th graders were given the choice of participating in the curriculum, and enrollments were high. Two 9th grade teachers attended the national

training, and these same two were personally responsible for the 9th grade curriculum. Prior to involvement in the project the teachers had felt successful with their students but they felt this new coordinated approach was the "way to go" in order to have all students study all the science. After the training the teachers were committed to the new philosophy and believed it would improve student learning. An outside, non 9th grade teacher served as the SS&C liaison person, facilitated their implementation of the course and its philosophy, and provided personalized encouragement to the teachers. No new teachers were required to teach the curriculum until several years after it had become well established. When new teachers were assigned, the former teachers guided them. The curriculum with some modifications continued throughout the six years of the study period.

2. This California site was a large multi-ethnic high school in a very large city. The school facilities were not always adequate for the needs of the curriculum, but the teachers worked hard to gather the necessary materials. The student body was more apathetic than problematic. All 9th grade students participated in the curriculum. Several teachers were responsible for the teaching of 9th grade science. Different subsets of these teachers attended the national training. Over half their students were failing 9th grade science, and they believed SS&C would help more students succeed in science. After the training the teachers worked as a group to develop the specific lessons for their school and met often to keep everything organized. They had a liaison teacher who taught 9th grade sometimes and who supported their efforts. The team supported any new teachers as they moved into teaching 9th grade. In order to better match a statewide testing program, the curriculum was modified after the first two years. This modified curriculum remained in place until the end of the study.

3. This Iowa site was a mostly Caucasian, medium-sized high school in the first ring suburbs of a moderately sized city. The school had sufficient resources to support the curriculum and large numbers of the students went on to higher education after high school. All 9th graders (except a small group of honors students) participated in the curriculum. Two teachers attended the training, and this same group was in charge of the teaching of 9th grade science for some time. They were experienced teachers and believed they were doing well,

but were willing to give the new philosophy and methods a chance, in order to give their students a better and more diversified science experience in 9th grade. The liaison teachers (one retired) were senior members of the science department who strongly supported the 9th grade teachers. One of the originally trained teachers came to "own" the curriculum, and she helped new teachers to understand the techniques and philosophy. Much of the initial SS&C curriculum remained in use during the course of this study, but it was continually modified and revamped to better fit what the teachers believed was necessary for their students.

4. This Texas site was a large, mostly African American high school in a very large city. The school facilities were not adequate to support the curriculum, and although teachers made efforts to obtain the necessary materials, they were generally not successful. The students were very polite although not particularly engaged in academics. All 9th grade students took SS&C. There was a group of three experienced teachers who attended the national training and some others who attended local training. A large group of teachers taught 9th grade over the course of the project because of high teacher turnover. For the first two years the new teachers were encouraged to teach using SS&C philosophy and lessons by the liaison teacher who was also the science area chair, but the liaison teacher was not part of the 9th grade team. She stopped being chair after the first year and retired. In the third year the State mandated a new course for 9th grade, so the SS&C curriculum was not used after that although some of the SS&C activities that fit into the new course were used by some of the teachers.

5. This New York site was a large ethnically mixed high school in a suburban area. The school had excellent facilities to support the curriculum. Only a subset of the students took the SS&C course, and most of these were not college bound. Several teachers attended the national training, and a large group of teachers was involved in teaching the 9th grade SS&C course because a different set taught it each year. The teachers in the school already had a hands-on, inquiry approach to science so the SS&C philosophy matched theirs. The teachers at the initial training adapted the curriculum to their needs and implemented that modified version. The liaison teacher was "in charge" and significantly encouraged the

teachers to implement the program. The State mandated a new course for 9th graders in the fourth year of the project, so the SS&C curriculum was not used after that.

Learning Environments

Despite the different elements affecting the teacher enhancement efforts at the schools, the project appears to have had a significant impact on the classrooms. The philosophy of SS&C, like that of the national standards, is one that calls for student-centered learning communities where students design and conduct their own investigations. For the first two years of the enhancement all of the sites but one showed significant changes from the comparison year in the types of activities used in science classrooms. All sites became much more student-centered in their instruction focusing on hands-on activities, group work, experimentation, the presentation of data or activity before the introduction of terms or concepts—precisely what the enhancement called for.

The following two scenarios capture some of the differences between comparison and SS&C science classes during the first two years.

Comparison Scenario:

Mr. Watkins had a good earth science lesson planned for the day and he knew the students would enjoy it. The students would be working on an experiment and he had all his materials placed conveniently on the lab tables. Mr. Watkins stood in the doorway and welcomed the incoming students and when the bell rang he took attendance. He began the class with a rhetorical question framing the day's activities which he then answered using overheads and models. He asked several students questions recalling previous earth science material that supplemented his presentation. After presenting the concept, he passed out the lab sheets and had one of the students read it to the rest of the class. He commented on any difficult parts and demonstrated procedures as the students followed along. When all questions were answered the students moved to the lab area and conducted their experiments sharing equipment in pairs. As the students completed the lab work, they went back to their seats and answered the questions on the lab sheet. Mr. Watkins then went over the questions with the whole group calling on students to read their answers. He reviewed the vocabulary and pointed out how the lab results confirmed the concept he had presented earlier. He then had the students re-state the concept in their own terms and ended the class.

SS&C Scenario:

Ms. Moore was looking forward to her class. There was an interesting earth science question to investigate and she was not sure what the students would find out. She had sets of materials out on the back shelf that the students could use. She welcomed the students as they came in and had them sit in their lab groups. She stated the topic for today's class and asked the students what they knew about it and if anything from the life science portion of the class related to this topic. Finally, she asked the students a question and asked how they might go about finding the answer. After listening to a few suggestions, she directed the students to use the materials to determine an answer. The students worked in their groups with Ms. Moore helping out as necessary when the group members could not answer their own questions. When all the groups had finished collecting their data, Ms. Moore asked them to report to each other what they had found out. The groups shared their results and their thoughts on answers to the lab question. There was a disagreement between two of the groups, which Ms. Moore suggested they could check on by doing some more lab work the next day. The students left the class debating their answers.

There were costs and benefits to these changes to the classroom environment. The student interviews and opinionnaires showed that the students were quite satisfied with their classes. The students thought the classes were fun, not too hard and that the best things were the activities. The teacher interviews, however, revealed their mixed feelings about the implementation effort. All of the teachers felt somewhat overwhelmed by the SS&C curricular requirements. In the first years the materials were being developed/revised as the teachers were using them so there was not a "tried and true" way to go with all the glitches highlighted and compensated for. This lack of organization did, however, tend to promote individual modification and adaptation to the sites' needs. In addition to organizing and selecting curricular materials, the teachers felt they had to spend unreasonable amounts of time preparing hands-on laboratory materials for the students to use. Furthermore teachers often reported having to buy materials on their own or having to use materials that were not quite right.

Although the teachers thought the SS&C hands-on approach and having the students use the materials before the concepts were presented were good ideas, they felt it was just too difficult to do as often as the curriculum recommended.

After the first two years of implementation the five sites that were followed longitudinally moved in different directions and the learning environments changed in accordance with these. The following charts show the movement over time in terms of the classroom environment measures. Although classrooms were observed and both students and teachers were asked about what activities occurred, the best predictor of student achievement was observation, so only those results are presented in this section. All data are presented in the by site sections of this report. The observation forms required coding classroom activity every five minutes. These codes were grouped into the student-centered, teacher-centered and, student and teacher-centered categories presented in the following charts.

Individual sites showed unique results, but in general, all the sites but one, showed significant increases in student-centered activities during the first years of implementation with corresponding decreases (not necessarily significant) in teacher-centered activities. Student-centered activities went from being used about 10-25% of the time to 40-90%. During the fourth year there were increases in student- and teacher-centered activity and some decreases in student-centered activity with Iowa and Montana remaining higher than the comparison year and with the other sites returning to comparison year levels. California seemed to lag a year behind the other sites. The two sites, which substantially continued with the reform, Montana and Iowa, showed the most gain and consistency in student-centered activities.

Figure 1
Classroom Observations
Percent of Time Spent in
Student-Centered Activities

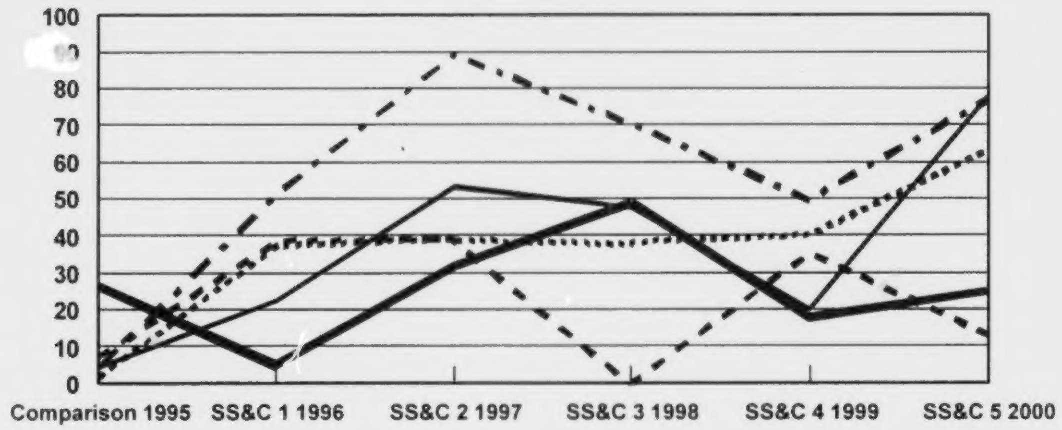
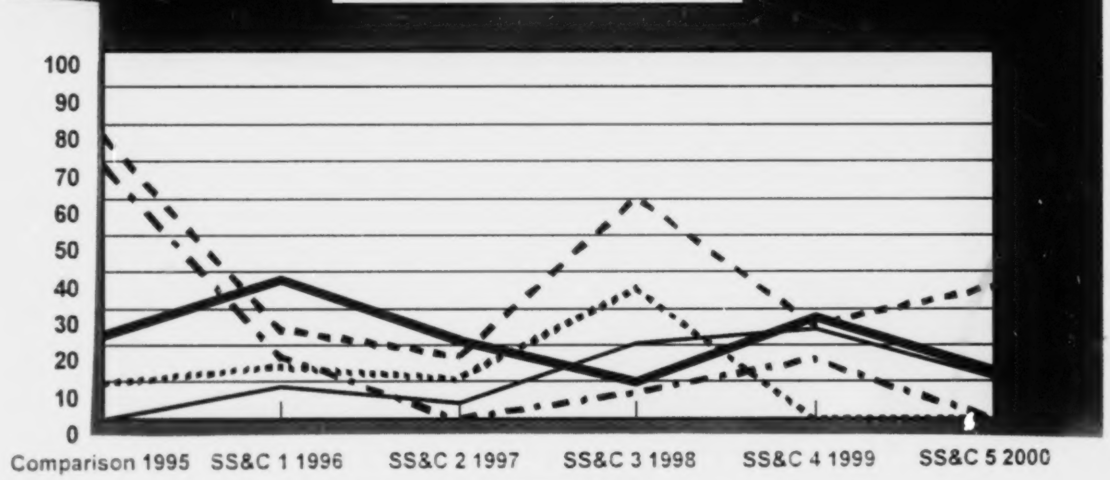


Figure 2
Classroom Observations
Percent of Time Spent in
Teacher-Centered Activities



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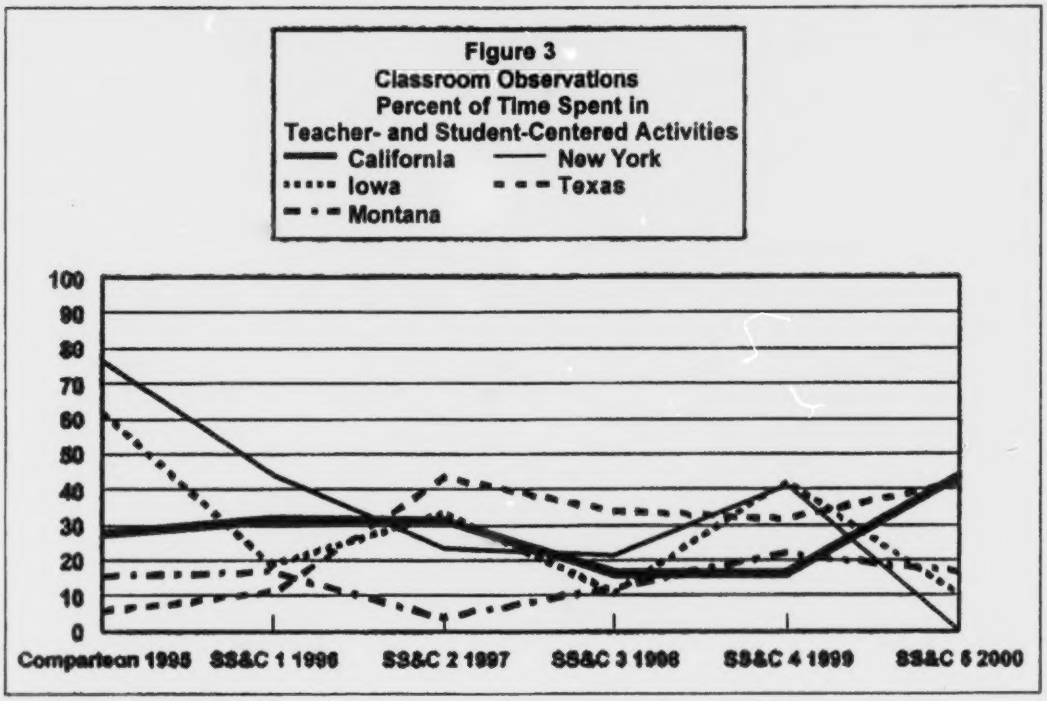


Figure 3
Classroom Observations
Percent of Time Spent in
Teacher- and Student-Centered Activities

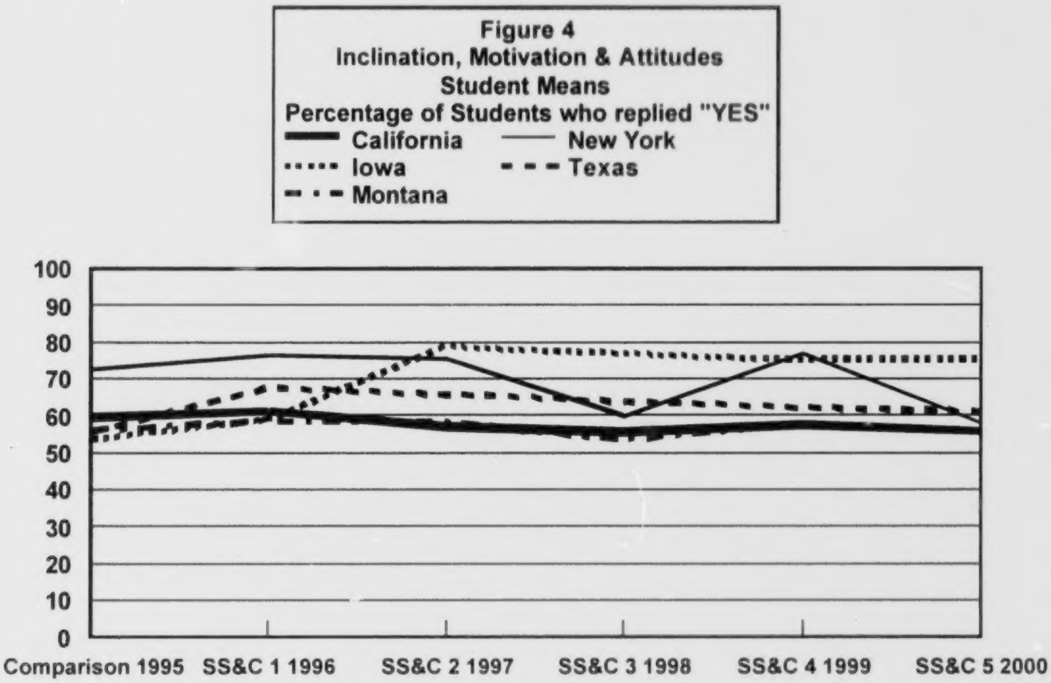
Attitudes and Motivation

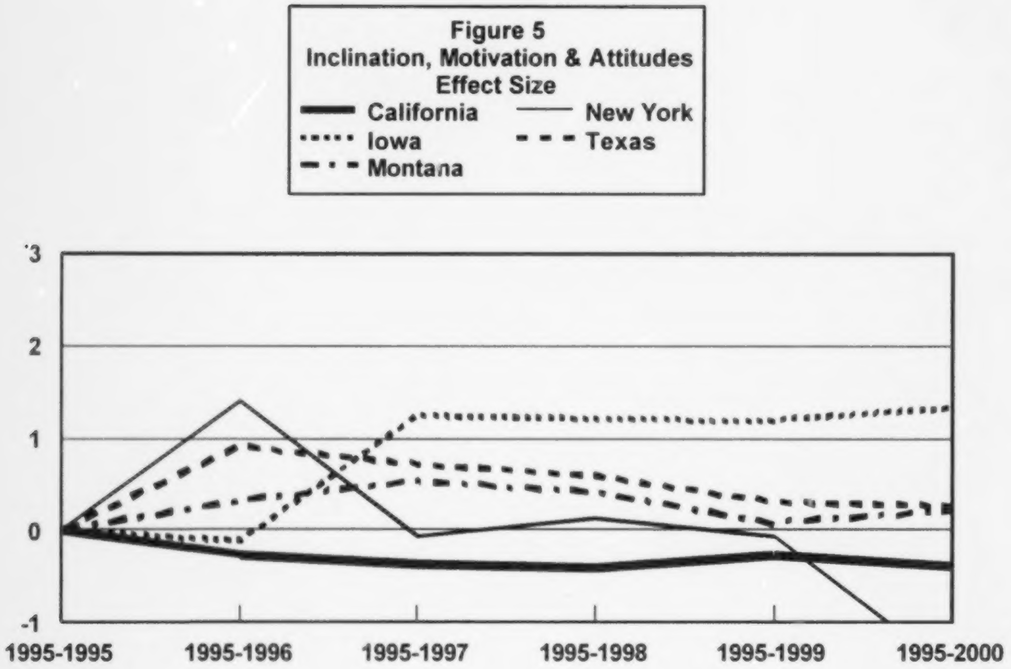
All of the 9th grade students at the five case study sites completed questionnaires that contained several items related to their attitudes and motivation toward science. A combined score from these items is presented here. The by site sections of this report contain charts displaying less aggregated results, and detailed results by item are included in the Tables in the Appendix.

The motivation, inclination and attitude data were combined to make one overall score for each school, each year, which served as an overall measure of affect. A score of "1" was assigned when the students answered "Yes" (they were inclined to take science or they were motivated). A score of "0" was assigned when the students answered "No" or negatively to the questions. The attitude questions were not "Yes/No" questions so they were re-coded as positive or negative attitude responses so that they could be combined with the inclination and motivation data. Surprisingly both the lowest and highest percentages of students saying "Yes" occurred in one site, Iowa, where the percentages ranged from 54% to 79%. Given this range it is clear that the majority of the students from all sites found science motivating.

In terms of the implementation, it would seem logical that the most immediate effect of more stimulating classroom learning environments would be improved student attitudes toward science. That, however, only occurred to some extent. In the first year of SS&C students at Texas and New York viewed their classes as significantly more motivating than the students had in the comparison year. In the second year the students at Iowa, Montana and Texas reported their classes as significantly more motivating, and this heightened level of motivation was retained in Texas for the third year and in Iowa throughout the course of the study. California showed significant decreases in all years but two. The effect size data for Iowa and Texas showed positive educational significance in several years as well. New York showed a positive, educationally significant effect size in the first year and a negative, educationally significant effect size in the last year.

Figure 4
Inclination, Motivation & Attitudes
Student Means
Percentage of Students who replied "YES"





Achievement

All of the 9th graders at the five sites completed measures of achievement. All students took the multiple choice and open-ended items, and randomly selected students completed the laboratory tests. The following charts show the movement over time in terms of the achievement measures.

The achievement results were mixed. There were initial and continuing significant positive changes in the students' scores on the laboratory measures but not on the paper and pencil, multiple choice and open-ended items. These quantitative findings were supported by the teachers' opinions. Teachers at several of the sites believed students who had taken SS&C were better prepared to conduct inquiry science. However the teachers also believed that the students needed more help to understand the concepts. They felt the students needed the concepts verbally explained to them and that the SS&C sequence of teaching by inquiry resulted in the students not really understanding the concepts and not learning the necessary facts and vocabulary. Teachers also felt the students did not get enough depth in each of the sciences. They felt the students got a little bit of earth science and then were off to something else in life science or physical science.

The lab skills performance test data showed fluctuation across the sites. The general pattern was higher scores after the comparison year. The range of percent correct was 41 (Texas) to 82 (Montana). In the years of the study there were 11 statistically significant differences in scores from the comparison year. In all but one year the Montana and New York scores were significantly higher than the comparison year score. The scores for Texas went back and forth between significantly higher to no difference. Iowa showed a significant increase only in the last year but also showed a consistently increasing trend away from the comparison year over the time period. California showed no significant differences. The effect size chart shows that Montana (1996, 1997, 1999 and 2000), New York (1996-1998 and 2000), and Texas (1996, 1998 and 2000) had positive educationally significant effect sizes. California had a negative educationally significant effect size in 1997.

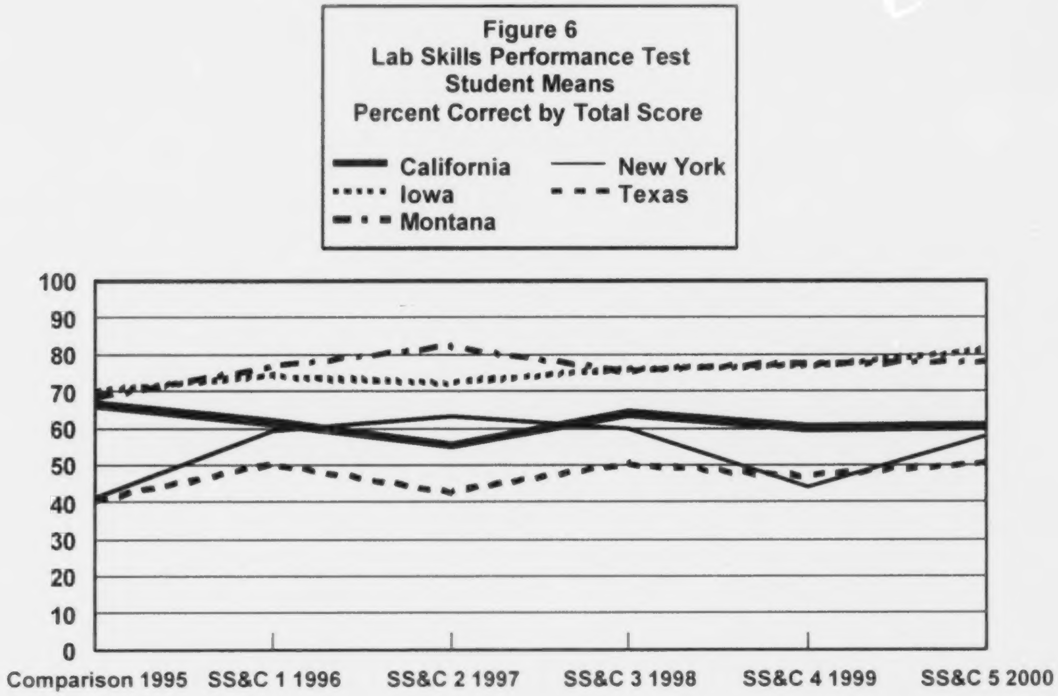


Figure 6
Lab Skills Performance Test
Student Means
Percent Correct by Total Score

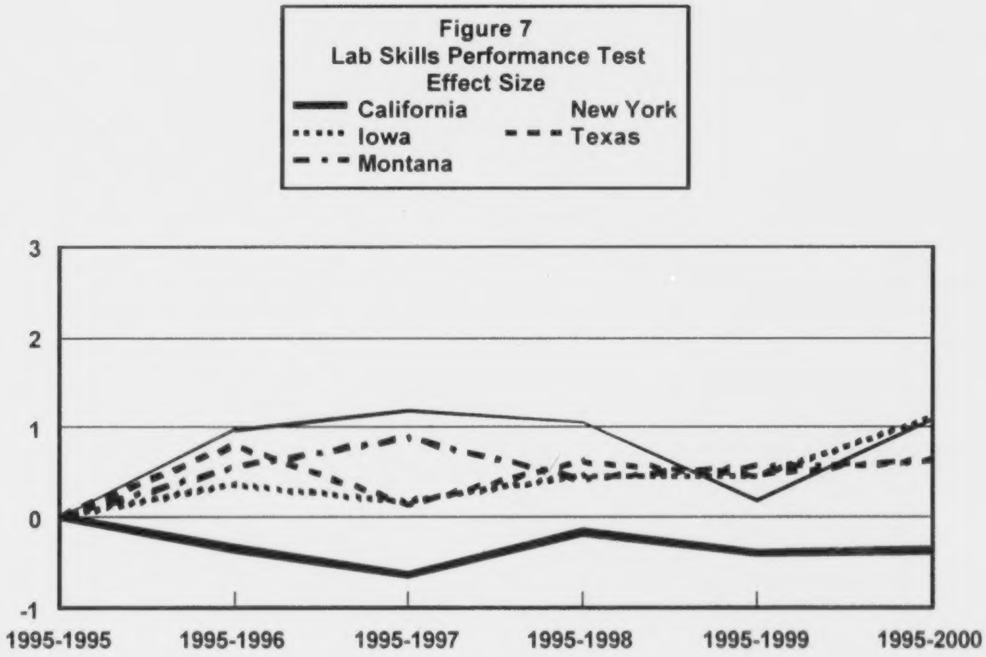


Figure 7
Lab Skills Performance Test
Effect Size

The science literacy multiple choice achievement test scores are almost the mirror image of the lab skills performance test scores. California showed a significant positive change while the other four sites showed no change or significant negative scores. The range of the percent correct was 33 (Texas) to 67 (Iowa). Iowa scores were significantly lower than the comparison year in all years; Texas scores were significantly lower than the comparison year in 1997, 1999 and 2000. California had significantly higher scores in three of the years. The effect size chart shows that negative educationally significant changes occurred for Iowa during three years and for Texas the last year.

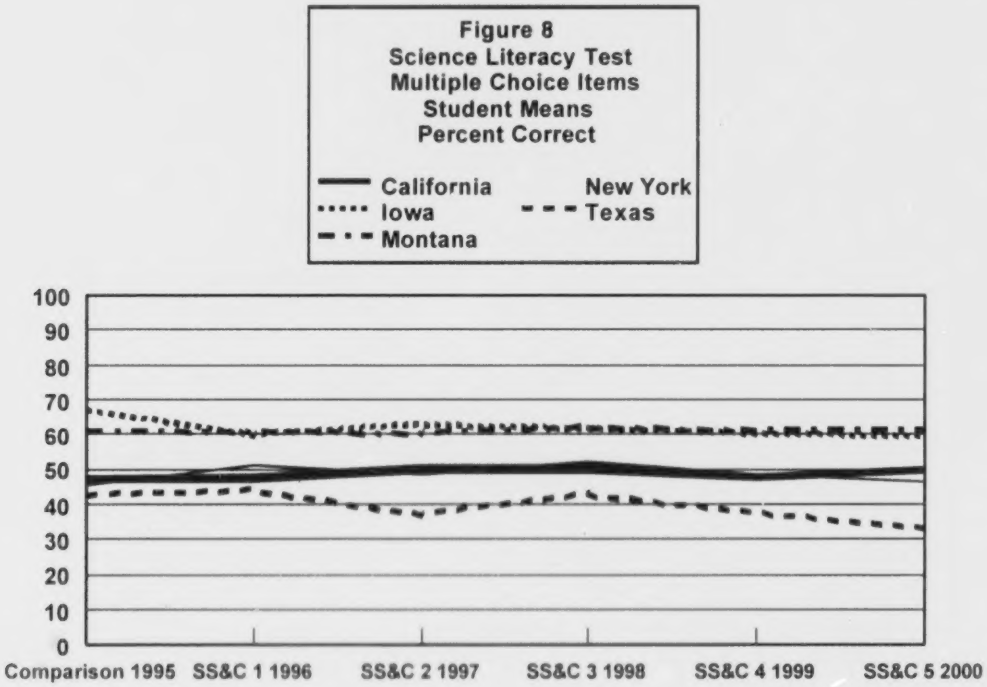


Figure 8
Science Literacy Test
Multiple Choice Items
Student Means
Percent Correct

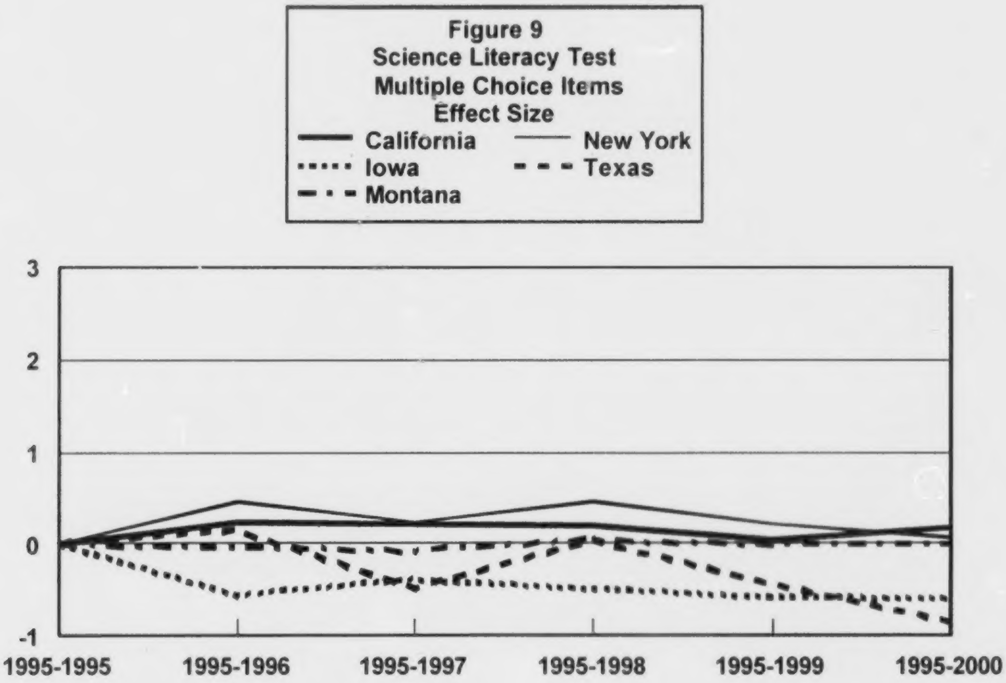


Figure 9
Science Literacy Test
Multiple Choice Items
Effect Size

The results on the science literacy open-ended measure were inconsistent with most scores wavering back and forth at approximately the comparison year levels. The range of percent correct from the science literacy open-ended questions was 10 (Texas) to 56 (Montana). New York (1996, 1997, 1998 and 2000) and California (1998) had scores significantly higher than the comparison year. Iowa (1996, 1999 and 2000), Texas (1999 and 2000), and Montana (1998 and 2000), had scores significantly lower than the comparison year. The effect size chart shows positive educationally significant changes in New York (1996-1998 and 2000) and California (1998). Iowa in 1996 and Texas in 1999 and 2000 had negative educationally significant changes.

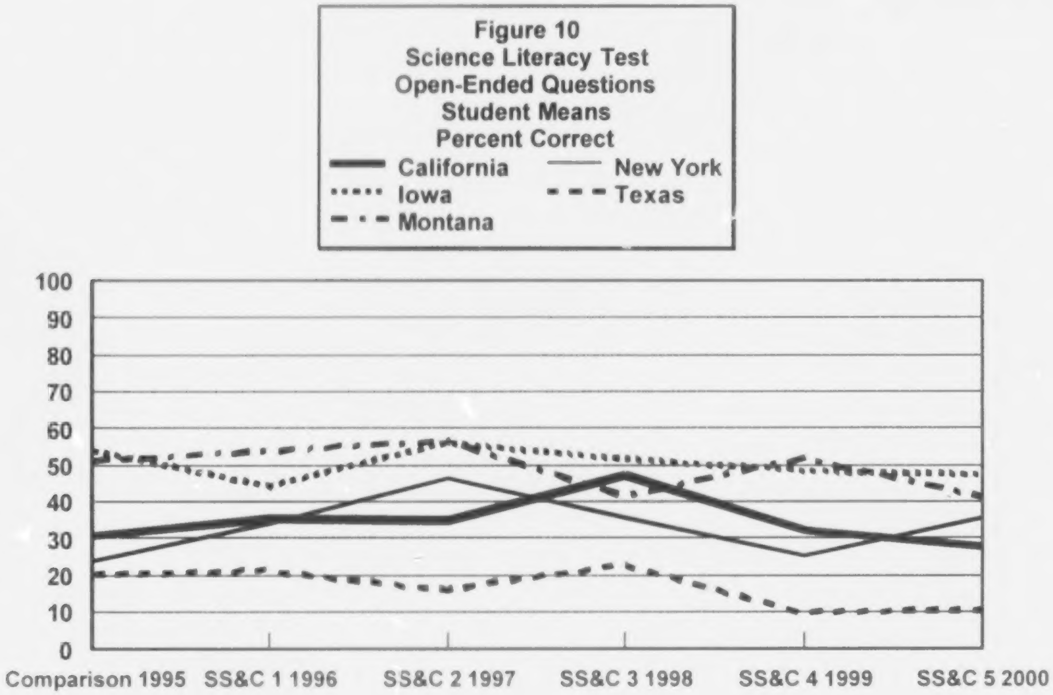


Figure 10
Science Literacy Test
Open-Ended Questions
Student Means
Percent Correct

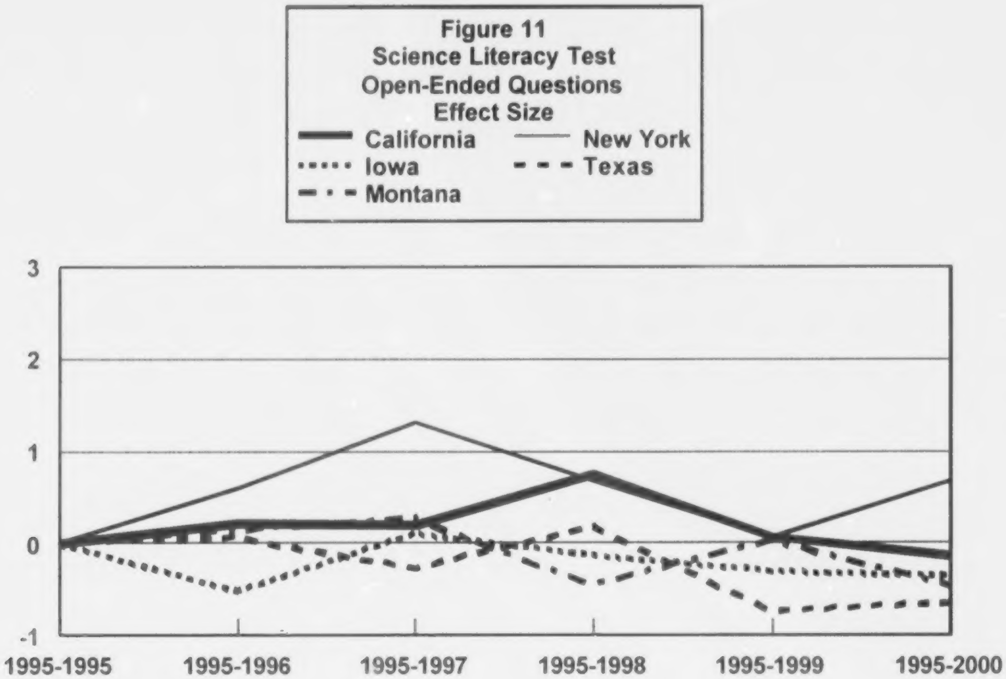


Figure 11
Science Literacy Test
Open-Ended Questions
Effect Size

Consolidated Impressions

Although the sites were diverse, it was possible to form some general impressions, which follow. These impressions were also synthesized into the theoretical model presented in the next section and formed the basis for the recommendations.

The most important impression was that each school was indeed a unique community. There were, of course, similarities, but each had its own personality, its own processes and its own goals. This uniqueness played out in many ways and affected everything that happened. Issues included the division of resources, the push and pull between different efforts at each school, and staff turnover. What the teachers were willing or able to do or what might receive the most attention or gain the most status determined what was implemented. The educational reform witnessed at these sites could probably best be explained in terms of how schools change reform, not how reform changes schools (Tyack & Cuban, 1995). The schools changed reform to fit their own wants and needs, not the wants and needs of the reform project directors.

A critical element was the structure for change within the schools. This was a complex relationship and involved many aspects of the schools: the teachers specifically charged with the implementation, the other teachers, the liaison teacher and external requirements. The teachers were independent professionals, often worked in isolation and ultimately made their own decisions. It appeared that the teachers were most likely to implement the reform when it was their own choice. This does not mean that they could not be encouraged to change, but that the change took time and the teachers needed to develop ownership of the change. They had to feel that they were doing it because they wanted to. This fits with the constructivist philosophy in that learners need to construct their "own" understanding of a phenomenon before they truly accept it.

Construction of understanding and the development of ownership take time. For an implementation to be successful it appears that it must be viewed as something that will continue and then actually be used for at least three years. This allows the teachers to try it out the first year, fix it and become more familiar with it the second year and then begin to make it their own in the third year. This model implies that the same teachers who attend training should also be responsible for implementing the changes and that they continue to be responsible for the change for at least the three years. It also implies that the group of teachers who are involved should be small enough so that each member of the team feels ownership and knows his or her input is needed. When pressures either inside or external to the school indicate that the curriculum may not last, teachers, probably wisely, do not invest the effort needed to develop ownership. Pressures can be positive or negative. For example, while this study was taking place there was heightened national interest in the National Science Education Standards, which the SS&C curriculum was designed to match.

Coupled with the notion that it has to be the teachers' own idea, is the initial state of mind of the teachers. At the sites studied, teachers' reasons for becoming involved in the change varied from not really wanting to be involved at all, to thinking it was worth a try, to believing this was really the "right thing to do." These "prior conceptions" about the curriculum and training appeared to significantly impact the success of the implementation. Teachers who initially believed changing would be important were more likely to implement change and develop ownership of it. Teachers who believed very strongly at either extreme either championed or sabotaged the change effort. Although reform efforts need champions, sometimes, these teachers were too pushy and ended up hindering the reform instead of helping it. Those in the middle are probably representative of most teachers involved in change. They want to do the "right thing" but are not sure what that is. They are usually concerned teachers who have been trying to do what they think is best for their students and so believe what they have been doing is good. This sets up a difficult belief-changing situation. The teachers have to change what they think has been good in favor of something they are not sure of. To accomplish this, the teachers needed evidence that the change they were participating in was truly the "right thing." They needed support from their school and colleagues, and positive feedback from the students.

The issue of support includes both material and emotional support. The notion of emotional support is complex. Teachers need support while experiencing change. They need to be led through the change carefully so that they will not feel defensive and reject or subvert it. They also need to be guided to truly understand the nature of the changes they are supposed to make. This takes a special type of support, a facilitator and guide, more than a banner waving, enthusiastic leader. It appears that at the sites studied, a guide who was not directly involved in the change was more effective, perhaps because this provided a perspective from someone who was not involved in the day to day challenges of teaching. It also appeared that these guides should be in a position of some power within the school structure. This provided the teachers with a conduit to the power structure and approval from someone in power. This sort of guide can also facilitate the obtaining of the recognition and materials teachers need to implement the curriculum.

Material support is less complex but no less important. If a hands-on active science program is to be implemented, the teachers need materials. The materials need to be thoroughly tested to make sure they consistently work in the ways they should. Additionally teachers need to have enough supplies for all of the students to participate. Just having the necessary materials is not enough. The materials also have to be easily accessible to support the lessons. For example, one site put all of the materials and supplies necessary to support each set of lessons into boxes much like the elementary school kit science curricular programs.

Feedback from students is valuable to all, but especially to teachers who are unsure about the value of the change in the first place. The feedback is necessary to support the efforts involved in making the changes. At the sites studied, the information about student outcomes was both formal and informal. Students were seen as more interested in science or more engaged during class, as becoming better at designing experiments or using scientific reasoning, or anecdotal comments were supportive of the changes, etc. More formal information was provided by the sites or through the evaluation effort, such as enrollment data, increases on attitude toward science measures, success rates on out-of-class or standardized science tests, etc. If the student assessment results did not support the change or the assessments measured things not being covered by the current curriculum, teachers modified the curriculum to optimize student results on the assessment.

Most educators anticipate that changes in classroom learning environments in terms of curriculum and instruction will be translated into more desirable student outcomes, i.e., if the teachers were indeed teaching better, the students should have better attitudes and perform better. Previous research has found that a positive learning environment and a more inquiry-oriented instructional technique can help increase student achievement (Fraser, 1986; Fraser et al., 1987; Shymansky et al., 1982). This was only partially the case in this study. Given the significant changes in the instruction documented in the first two years, there were surprisingly few increases in student outcomes although changes were seen at some sites in motivation, and lab skills performance improved at most sites. Since extent of implementation varied after the first two years, it is difficult to make overall statements. At the sites that continued, however, it appears there was a consistent gain in the lab skills performance. There was a very small overall negative effect on the science literacy multiple choice and open-ended tests.

It is difficult to explain the lack of an effect given the strong changes in the learning environments. First it must be kept in mind that the achievement tests were not tied to the specific content covered in the SS&C curriculum. Tests were tied to the NRC standards and therefore were a very broad look at student achievement not a look that was designed to determine if a student learned what was taught. Nevertheless the tests were psychometrically strong: the scales show strong factor structure and the reliabilities are high. The items were selected from existing and highly valid tests so the items themselves should be valid. Independent science education experts examined the tests and stated they matched the standards they were designed to measure. The tests show expected results in terms of higher scores for students who have higher grades in school, standard patterns for achievement for different ethnic subsets and gain in achievement for the sample overall from 9th grade to 10th grade.

A possible explanation is that the learning environment has less effect on student performance than most would like to believe. Comparing the data in a slightly different way supports this notion. There were no differences in achievement in specific science areas between comparison and SS&C year students even when comparison students had studied a particular science area for the entire year while SS&C students had studied it for only part of a year. For example, in the 10th grade comparison group sample almost all of the students took life science for the whole school year, yet the comparison group students did not score higher in life science than the SS&C students who only had life science part of the time. As another example, the SS&C students who had studied earth science did not perform better than the comparison group students who had not studied this area.

Overall it appears that the reform effort was successful in causing changes in the way science was taught. The initial appearance and persistence of these changes, however, were dependent on the different elements present at the sites. Some sites and individual teachers gained and retained more from the reform effort than others. The institutionalization of change in a school was greatly affected by external pressures, the power structures in the school in relation to the reform, the availability of support and the desire for change. The data showed that if the same teachers continued to teach the reformed curriculum and worked on adapting it to match with their environments, their students' achievement was more likely to be affected. Perhaps, as teachers become more experienced with reform, they become more comfortable teaching it, teach it more effectively, and convey clearer expectations for student performance.

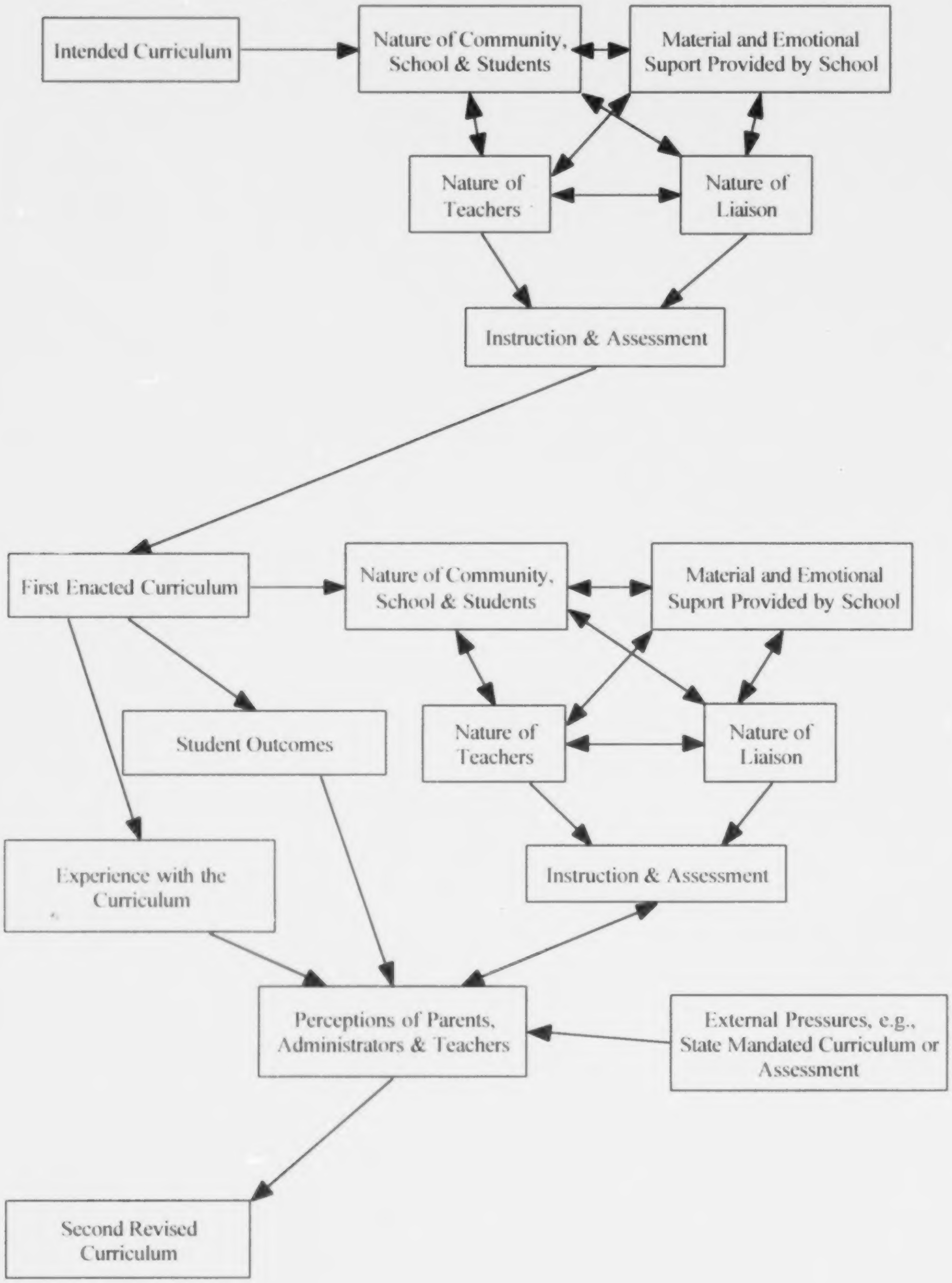
SS&C Model for Curricular Implementation

The model for curricular implementation in Figure A was distilled from the SS&C experience. It is based on the notion that the intended curriculum is filtered and modified by a variety of different contextual factors. In the case of SS&C, the original curricular materials developed by NSTA were intended to be consistently implemented in all 13 sites across the country. In reality each site modified materials based upon the unique features of their school.

The flow chart of curricular implementation in Figure A visually describes how the intended SS&C curriculum was first filtered through four inter-related factors: the community, the school and the students; the material and emotional support provided by the school; the teachers; and the liaison. Each site started with the materials developed by NSTA, but then considered how the materials could be used in their school with their own unique student population. The intended curriculum was also filtered through the support provided by the school and the resources available. The nature of the teachers, such as their content understanding, teaching philosophy, and openness to change, and of the liaison, such as his or her connections within the school power structure and facilitation skills, were also critical components of the curricular implementation. Ultimately, it was the teachers and the liaisons who made final decisions about the instruction and assessment that was used in the class.

This resulted in the first enacted SS&C curriculum. This enacted curriculum was once again filtered through the same factors; however, this time around student outcome data and experiences with the curriculum were available. The teachers, parents and administrators had perceptions about the effectiveness of SS&C and these perceptions served as another filter for the curriculum. External pressures also impacted the SS&C curriculum. State mandated curriculum and assessment modified the implementation of SS&C at some sites. The result of this second filtering process was the implementation of the second enacted SS&C curriculum. Theoretically, the process could continue into the future. Each year the curriculum is modified and reconsidered based upon student outcomes, the local context, and external pressures. The result is a cyclical curriculum implementation process that reconsiders and implements a modified curriculum each year.

Figure A: SS&C Model for Curricular Implementation


Intended Curriculum
Nature of Community, School & Students
Material and Emotional Suport Provided by School
Nature of Teachers
Nature of Liaison
Instruction & Assessment
First Enacted Curriculum
Nature of Community, School & Students
Material and Emotional Suport Provided by School
Student Outcomes
Nature of Teachers
Nature of Liaison
Experience with the Curriculum
Instruction & Assessment
Perceptions of Parents, Administrators & Teachers
External Pressures, e.g., State Mandated Curriculum or Assessment
Second Revised Curriculum

Recommendations

Recommendations for Effective Implementation Through Teacher Enhancement Efforts

1. Recognize that each school and teacher is unique and that consequently each implementation will also be unique. A project-wide curriculum will be modified by individual sites.

2. Recognize that external pressures such as curricular and assessment requirements may significantly impact the new curricular implementation.

3. Obtain district commitment to continue the implementation for at least three years with most of the same teachers. Effective change takes time.

4. Obtain district commitment to provide the necessary facilities and materials as well as support a process for making the materials easily accessible.

5. Involve teachers who either want to make a change or who are willing to try it and withhold judgment until later. Do not force the change on the teachers.

6. Have small groups of the teachers who will be directly involved in the implementation attend training.

7. Involve teachers in the development of the curriculum materials to help develop ownership and to help guarantee ease of implementation, but do not expect teachers to write the curriculum per se. The support of professional curriculum developers is needed.

8. Provide personally supportive, local liaison teachers who have the knowledge necessary to be effective guides and who are part of the power structure. They can give the implementing teachers access to power and provide official support and sanction for their efforts.

9. Gather and provide evidence to the teachers and schools that the changes are producing valuable effects.

10. Develop strong communication networks within and between sites, and between sites and the centralized project staff to increase teachers' feelings of involvement and ownership in the project. The need for consistent and formalized avenues of communication increases as the number of implementation sites increases.

Recommendations for Longitudinal Evaluations of Teacher Enhancement Projects

1. Use the school or classroom as the unit of analysis with quantitative data and/or employ HLM techniques.

2. Build rapport with the school and teachers to facilitate the data collection. Have a contact teacher in each school who can help evaluate to meet data collection needs.

3. Carefully document everything that is done throughout the project and develop comprehensive filing systems that allow back-ups of all vital materials.

4. Select evaluation team members who will be able to participate over the whole course of the study.

5. Bring new people in and out of the evaluation team to provide new insights and energy.

6. Have an external evaluation consultant to the evaluation effort who can review and refine your approaches.

7. Produce publications or reports as the project progresses. These reports could be on the main topic or involve more research oriented special questions or interpretations

about the data being collected.

8. Include sufficient funding for strong clerical help in formatting reports, tracking data, editing, and numerous other administrative tasks.

9. Be vigilant in data analysis. Conduct routine crosschecks of data analysis procedures. Have more than one-person conduct analyses to serve as a crosscheck. Doing "side" studies can help to identify weaknesses in the analyses.

V. INDIVIDUAL SITE DATA AND IMPRESSIONS

This part of the report describes the data from each individual site in greater depth. For each site, the report first describes the context of the school qualitatively, including the nature of the community, school and its students; the nature of the teachers; the nature of the SS&C project liaison; the support provided by the school for the SS&C project; the external pressures on the school; and the progress of the implementation of the SS&C project. Then the report presents the quantitative data for each site. These data are presented in three sections: Learning Environment Measures, Student Outcomes: Attitude & Motivation, and Student Outcomes: Achievement. The charts for each site show trends over the six years of the study. For each site, identical calculations and analyses were used. These analyses are described in detail in Appendix B, *Instrument Descriptions*, and notable analyses are also described here. The tables in the Appendix present detailed, by item data in addition to the more aggregated data presented in the charts.

- Unit of Analysis

In all analyses, the student or teacher was used as the unit of analysis because the number of classes at the five schools was not large enough to allow using classes as the unit of analysis. The student and teacher sample sizes were small. For the instruments administered to the highest numbers of teachers and students, the teacher and student questionnaires, data were collected from a maximum of 6 and minimum of one teacher and a maximum of 397 and minimum of 10 students.

- Statistical Significance

For each state, changes were reported only when they were statistically significant at $p \leq .05$. Such changes were referred to as "statistically significant" or "significant" in the text.

- Effect sizes

Effect sizes for inclination, motivation, attitude, and all achievement measures were reported for each State on charts and in a table in the Appendix. Effect size (d) is a measure of the degree to which two means differ in terms of the standard deviation of the parent population. In this study, the scores on all of the measures administered in the years after the reform was implemented (1996, 1997, 1998, 1999, 2000) were contrasted with the scores on the measures in the comparison year (1995). Because of the large differences between the years, the standard deviation was calculated for each pair of years separately. The measure of standard deviation used was the " square root of the pooled variance" for the two years being compared for each instrument. This procedure best controlled for statistical bias and error. The formula used was: d=Mean1-Mean2/square root of pooled variance$_{\text{within group}}$. The effect size chart allows us to consider relative educational significance in addition to statistical significance. For the purposes of this report, an effect size of ± 0.5 was considered to be educationally significant.

- Science Literacy Test Analyses

The science literacy open-ended test and multiple choice test data were analyzed using both z-tests and the Mann-Whitney U test because of low sample sizes. Results from the two statistical tests were similar, and z-scores were used here to determine significance and are reported in the tables in the Appendix.

- Student and Teacher Questionnaire Factor Analyses

The data relating to class activities were regrouped for the purposes of analysis on the student questionnaire and the teacher questionnaire. Factor analyses were conducted on both instruments using the data from the 1995 and 1996 years of the study because those years included data from all thirteen schools that were part of the original project. The sample sizes for those two years were therefore large enough to justify the use of factor analytic techniques.

The table below shows the results of those factor analyses. Four factors emerged on the student questionnaire and two factors emerged on the teacher questionnaire. There was a great deal of correspondence between the factor analysis results on each instrument. On the inquiry scale, two of the four items making up the scale emerged on both the student and teacher questionnaires, Ask students to suggest hypotheses and Ask students to interpret data. The three items making up the traditional scale were the same on both the student and teacher questionnaires, Read articles on science, Do an oral or written report, and Read other science materials.

Scale	Student Questionnaire	Teacher Questionnaire
Inquiry	• Demonstration of a scientific principle • Ask students to suggest hypotheses • Ask students to interpret data • Relate previous work to current topic	• Do experiments • Ask for reasons for the results of experiments • Ask students to suggest hypotheses • Ask students to interpret data
Groups	• Do experiments with other students • Work in groups • Share results from experiments	
Traditional	• Read articles on science • Do oral or written report • Read other science materials	• Read articles on science • Do oral or written report • Read other science materials
Other	• Watch films, slides or videos • Go outside for class instruction	

The frequency of the class activities included in the creation of the new groupings and the resulting new scale scores were reported on a five-point Likert scale ranging from 1= "Never" to 5 = "Almost every day" for both the student and teacher questionnaires. Additional analyses were conducted on the student questionnaire exploring the percent of time spent in each kind of activity: inquiry, groups, traditional, or other. This percentage was calculated by adding together the scores for each scale in order to obtain a total score (inquiry + groups + traditional + other). Then each scale score was divided by the total score and multiplied by 100 to obtain a percent of time spent in that activity (e.g. percent time spent in inquiry activities = (inquiry/total score) * 100). The results of these analyses are reported in Tables 1-4 in the Appendix and in each State's class activities charts.

VI. CALIFORNIA HIGH SCHOOL

Detailed information about this site is contained in prior reports. What is presented here is a description of the implementation effort at the site in terms of the nature of the community, school, and the students, the teachers involved in the implementation, the liaison person, the emotional and material support provided by the school, external pressures and the progress of the implementation effort.

Nature of the Community, School and Students

During this study, California High School was a large, 9th-12th-grade high school located in an urban area in the State of California. The school suffered from problems of overcrowding, lack of resources, and lack of building maintenance. It had a large sprawling campus with several one-story concrete buildings. Because of an overcrowding problem, temporary classrooms were constructed near the football field. The buildings appeared run-down, dirty, and in need of regular maintenance. Some of the windows were broken, and graffiti could be found on many buildings. A chain-link fence surrounded the school, and students only entered the building through one door that was heavily monitored. Security at the school was tight, and police presence in the building was quite evident. Teachers also watched the halls closely during passing periods and were always on the alert for trouble.

The student population at California High School was quite diverse. In fact, it was one of the few schools in this study where one could find approximately equal numbers of Caucasian, African American, Hispanic/Latino American and Asian American students all in the same class. The majority of the students at the school came from low income, working class families. Approximately one-third of the students in the school had a first language other than English. Most students were not college-bound and did not appear to put a lot of effort into their schoolwork. It was a daily struggle for teachers to engage the students in learning, keep them on task, and get them to turn in assignments. Many students failed classes or barely passed their classes.

Nature of the Teachers

At California High School there were six class periods during the day, each lasting 50 minutes. There were approximately 20 classes of 9th grade science with approximately 25 to 30 students per class. Over the years there were six or seven 9th grade science teachers. Four of the teachers were at the school for more than 15 years, and these four teachers taught 9th grade during the comparison year and taught SS&C science each of the following years. The other two or three 9th grade teaching slots changed from year to year. In each year of this project there was at least one new teacher teaching 9th grade SS&C. These new teachers taught at the school for one or two years and then left. At times, the department had to fill one of the 9th grade science openings with a long-term substitute because they were unable to hire a licensed science teacher. The short-term teacher and turnover issues appeared to affect both the comparison year and all subsequent SS&C years.

There was a core group of four teachers who focused on implementing SS&C. Two of these teachers attended the summer workshops and training and led the SS&C implementation at this school. The core group of four teachers all appeared very committed to facing the challenge of working with the student body. They regularly arrived at school early and stayed late into the afternoon. They met as a team over the lunch hour and met regularly after school to discuss lab activities and modify the new SS&C curriculum. During the implementation of SS&C this core group of 9th grade teachers also worked long hours gathering materials, modifying lab activities to fit their equipment, and discussing changes after trying out activities.

Nature of Liaison

The liaison at this school was the science department chair during the first three years of the project. After three years another veteran teacher took over department chair responsibilities. The liaison was one of two teachers who attended the national summer workshops and training sessions, and led the SS&C implementation at California High School. During each year of the project he also taught several sections of 9th grade SS&C. He led the pilot testing and revision of SS&C activities, and was a leader in helping the new teachers and the long-term substitutes learn how to implement SS&C. The other teachers in the department appeared to respect his expertise and followed his advice. He was also instrumental in obtaining additional resources from the principal to organize the equipment for each SS&C activity so that in future years they could easily access the materials they needed for each activity.

Support Provided by the School

The principal at California High School was very supportive of SS&C. During an interview, he said that the science department was one of the best departments in the school, and he was quite impressed by their commitment and desire to make their classes better. He was disappointed in the low science test scores and concerned about the large percentage of students that failed 9th grade science, but he was encouraged that the department was at least attempting to improve the situation. Money and space were both at a premium in the school. Despite these constraints the principal provided money to help purchase additional equipment and storage cabinets so the science department could organize the materials. In addition, the administration added running water to several science classrooms to help teachers implement SS&C.

External Pressures

In the third year of SS&C the State of California required all schools to administer a 40 question multiple choice physical science test at the end of 9th grade. This placed pressure on the science department to reorganize the subject matter emphasis in the 9th grade. SS&C was originally designed to include an equal balance of physics, chemistry, biology, and earth science. Because of the new State physical science test, the department decided to shift the 9th grade course focus to physical science and cover biology and earth science in the 10th grade.

In addition, the new State mandated physical science test pressured the department to alter assessment methods. When SS&C began, the 9th grade teachers shifted to predominately essay, problem solving, and performance-based assessments. However, when the state began the multiple choice testing, the department decided to revert back to more multiple choice testing in order to prepare students to answer these types of questions on the end of the year test. They did not completely revert back to all multiple choice tests, but they definitely shifted the emphasis back to traditional testing.

Progress of the Implementation

In the first year of the project California High School converted all of their traditional 9th grade physical science classes to SS&C. During the first two years of the project a core group of teachers made a good faith effort to use an inquiry-oriented sequence as prescribed by SS&C. During the third year of SS&C California High School continued to implement SS&C as intended; however, they slowly began to replace and modify some of the SS&C activities that they did not think worked well. They still implemented approximately half of the priority SS&C activities; however, they used many of their own activities too. Despite the alterations in the activities, the philosophy of SS&C remained intact. The new activities used by the teachers used an SS&C-like sequence, meaning that they were more inquiry oriented in nature. In addition, it was during the third year of the project that California High School shifted the physical science activities to the 9th grade in response to the new end-of-the-year physical science test. To date, the science department continues to use this format for 9th grade science.

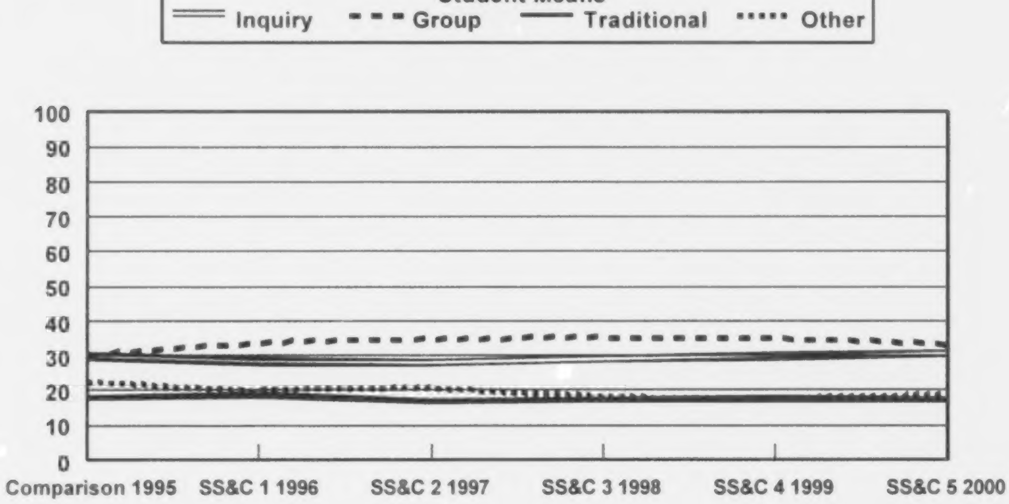
Based on the teachers' reports of what topics were covered each year, with the introduction of SS&C there was a decrease in the amount of earth science instruction, and an increase in physics and biology. (See Table 27 in the Appendix.)

California High School Learning Environment Measures

The learning environment was assessed in four different ways. The students and teachers completed a questionnaire that asked about what activities occurred in the class. These activities were grouped into factors. On the student questionnaire there were four factors: inquiry, group work, traditional, and other. On the teacher questionnaire there were two factors: inquiry and traditional. The introduction to the individual site sections describes these factors and their analyses in detail. The third measure was observations of the classes by external observers. These observations allowed the class activities to be categorized into student centered, teacher centered, group, administrative and other. The fourth measure was a learning environment inventory with several scales related to the classroom psychosocial environment, which was completed by the students.

The learning environment at California High School changed significantly during the course of the SS&C project. When forced into percent of total class time categories, the student questionnaire data showed a significant increase in the percentage of time students worked in group activities during all five years of the study. In 1996 and 1997 there was a slight significant decrease in the percentage of time teachers used inquiry-based activities; however, students reported a significant, slightly more frequent use of inquiry-based activities. Inquiry activities occurred approximately once a week during the comparison year and somewhere between once a week and several times a week during the SS&C years. The percentage of time spent on traditional lecture-based activities stayed constant during the project in all but one year. During the majority of the years of the project, students reported a significant increase in specific inquiry teaching techniques such as demonstrating scientific principles, relating previous work to the current topic, and asking students to interpret data. They also reported an increase in specific group activities such as doing experiments with other students, working in groups, and sharing results of experiments.

Figure 12
Student Questionnaire - California
Percent of Time Spent by Class Activities
Student Means



The teacher questionnaire data were not forced into percentages like the student data. Only the frequencies are presented below. There was a significant increase in inquiry teaching during the third and fourth years of SS&C. Traditional teaching increased significantly during the second year only, but otherwise remained constant throughout the project.

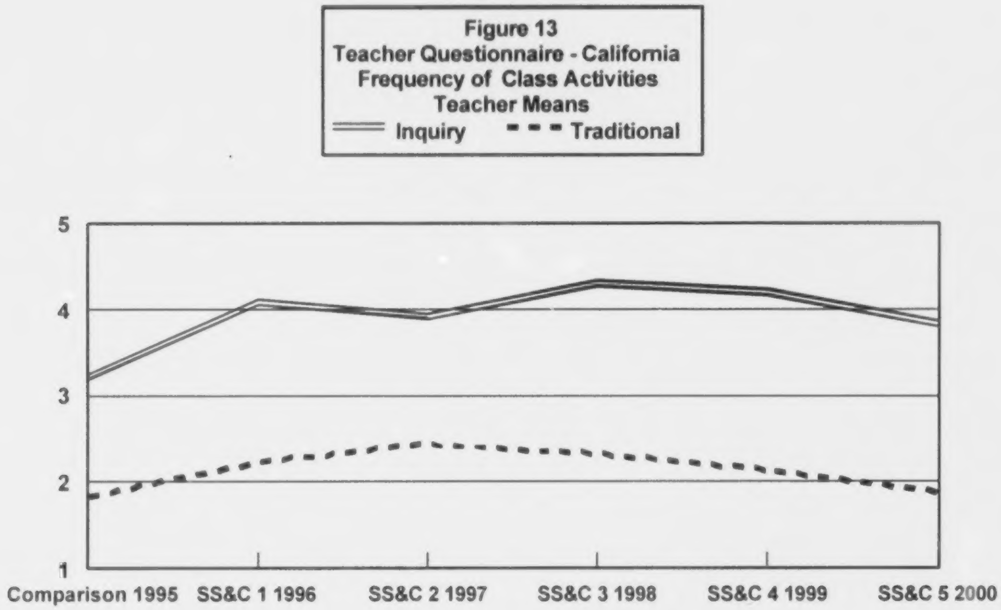


Figure 13
Teacher Questionnaire - California
Frequency of Class Activities
Teacher Means

During the last three years of the project, questions were added to the teacher questionnaire. The teachers were asked to rate the percent of time they spent in whole class activities, group activities and individual activities. After doing these ratings the teachers then described what happened in each category. The teacher reports on the percent time spent on group versus whole class activities showed that group activities were more common during the last three years of SS&C. Of the group instruction activities, hands-on activities seemed to dominate. In terms of whole class activities, class discussions were most common. (See Tables 34-36 in the Appendix.)

The class observations revealed that during the comparison year there were approximately equal amounts of teacher-centered and student-centered teaching. During the first year of SS&C there was a significant increase in teacher-centered activities (approximately 40% of class time), followed by a decrease back to comparison year levels in the second year (30% of class time). In the third year of SS&C there was a significant increase in student-centered instruction (50% of class time). The fourth and fifth years there was a move back towards more teacher-centered and more teacher- and student-centered instruction (30% each year). Overall, the learning environment measures appeared to parallel the implementation of SS&C at California High School. SS&C produced more group activities and more inquiry-based teaching; however, the use of inquiry techniques was difficult to sustain. The changes in instruction appeared to peak in the third year of the project and began to revert to comparison year levels by the end of five years.

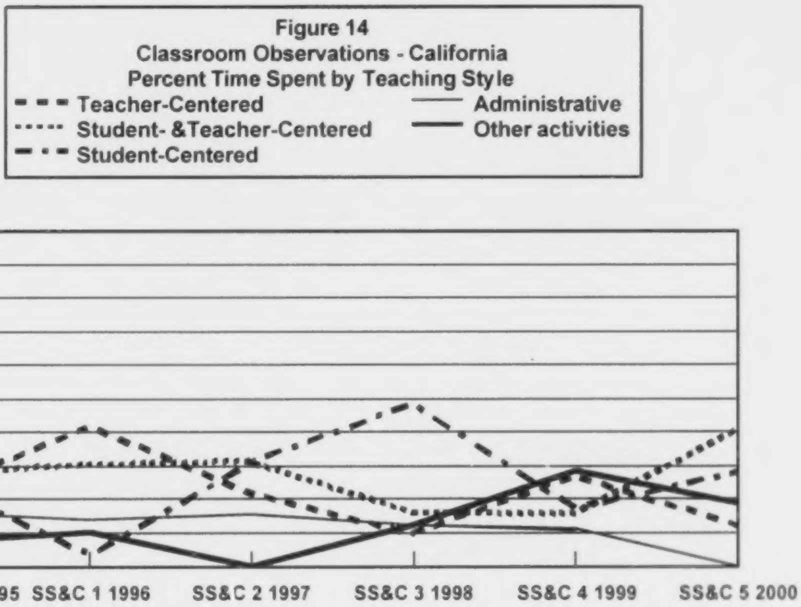


Figure 14
Classroom Observations - California
Percent Time Spent by Teaching Style

As a second look at the classrooms, the observation forms asked the observer to rate the level of student involvement and type of instruction. The ratings of student involvement showed no significant changes over the project. There was a significant increase towards more inquiry-oriented instruction during the last three years of SS&C.

The learning environment inventory scales indicated the SS&C curriculum was viewed as significantly less difficult during all five years of the project. The sequencing and experimenting scales indicated that SS&C used a significantly more inquiry-oriented sequence during the first four years of the project, and significantly more experimenting during the first three years of the project.

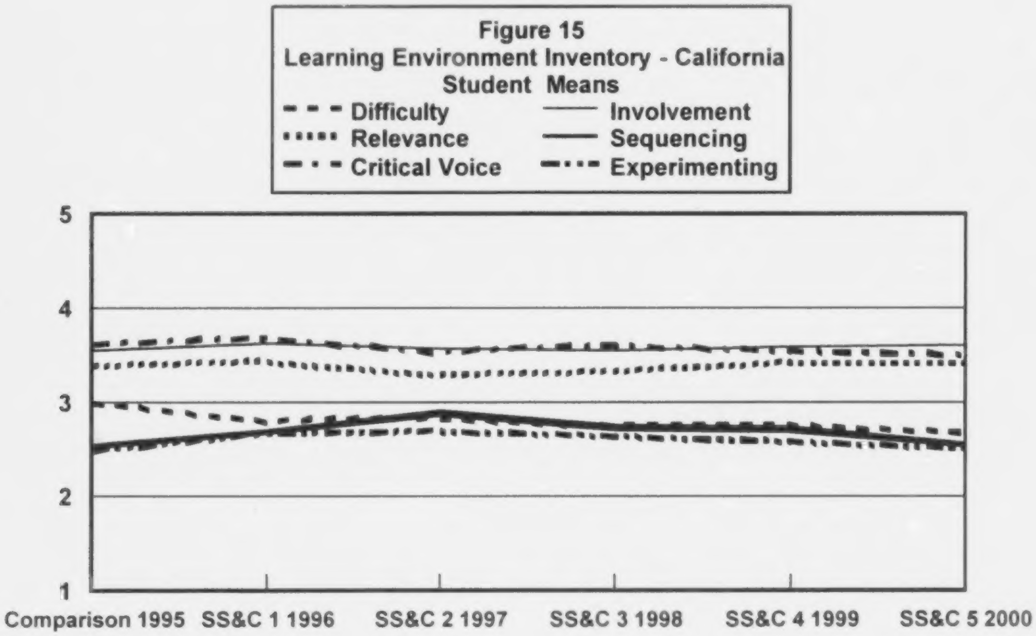


Figure 15
Learning Environment Inventory - California
Student Means

There was a relatively significant amount of variability in scores from year to year. This seemed to correspond to the changes in teachers from year to year and to the difficulty this created in terms of consistent implementation.

California High School Student Outcome Measures

The student outcome information is grouped in two ways. The inclination of students to continue studying science and student motivation and attitude toward science is one group, and student achievement on the science literacy multiple choice items, science literacy open-ended items, lab skills performance test, and written full investigations is the second.

Attitude & Motivation Measures

There were only minor changes in attitudes at California High School. In 1997, students' inclination to take science in 10th grade significantly increased slightly. In 1997, 1998, and 2000 there was a significant decrease in the percentage of students who stated that the activities in science class made them want to take more science and that science class is fun. There was also a significant decrease in 1997 in the percentage of students who found class motivating, and a significant decrease in 2000 in the percentage of students who found class interesting. In 2000, there was a slight significant increase in the percentage of students that stated the things they learn in science class relate to the real world.

Figure 16
Student Questionnaire - California
Inclination to Continue Studying Science
Percentage of Students who Responded "YES"

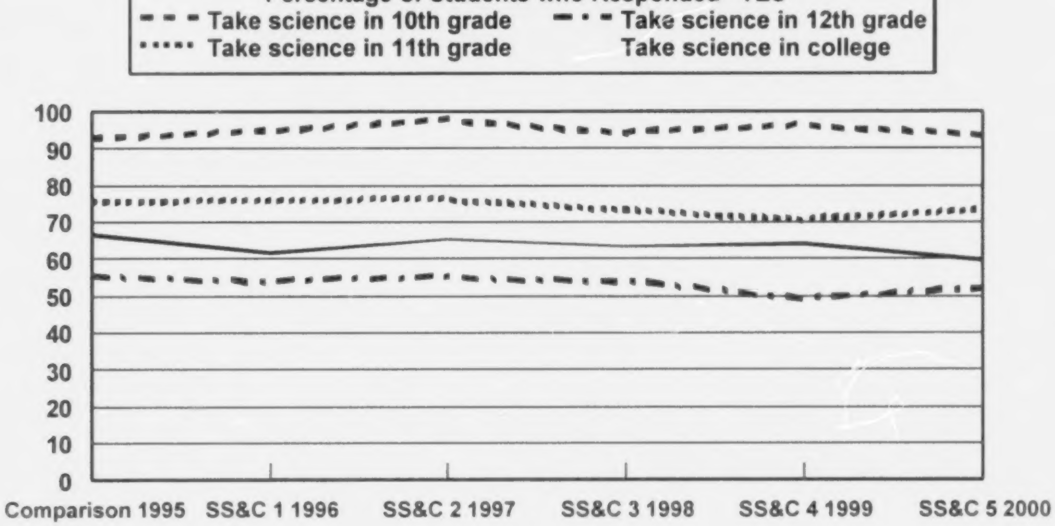


Figure 17
Student Questionnaire - California
Science Motivation

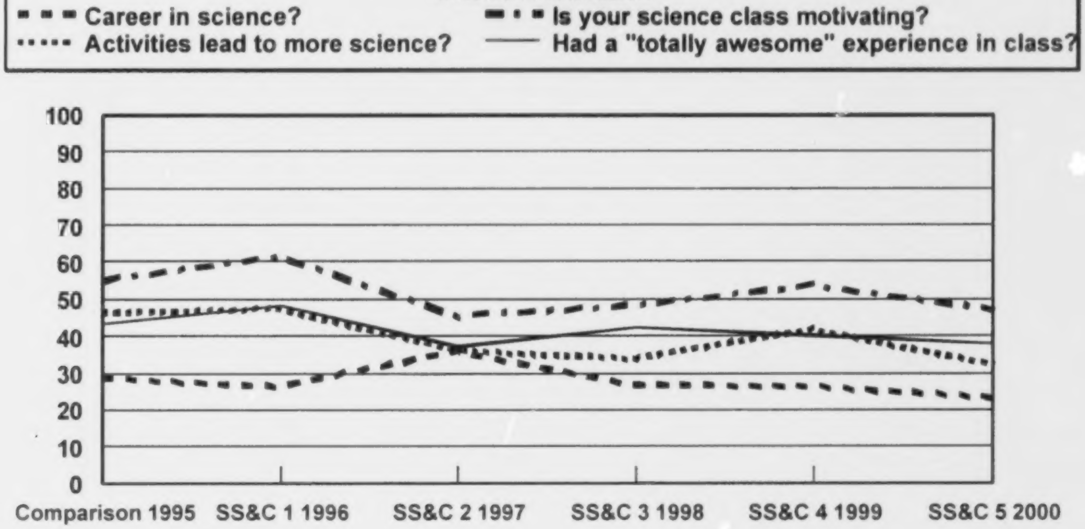
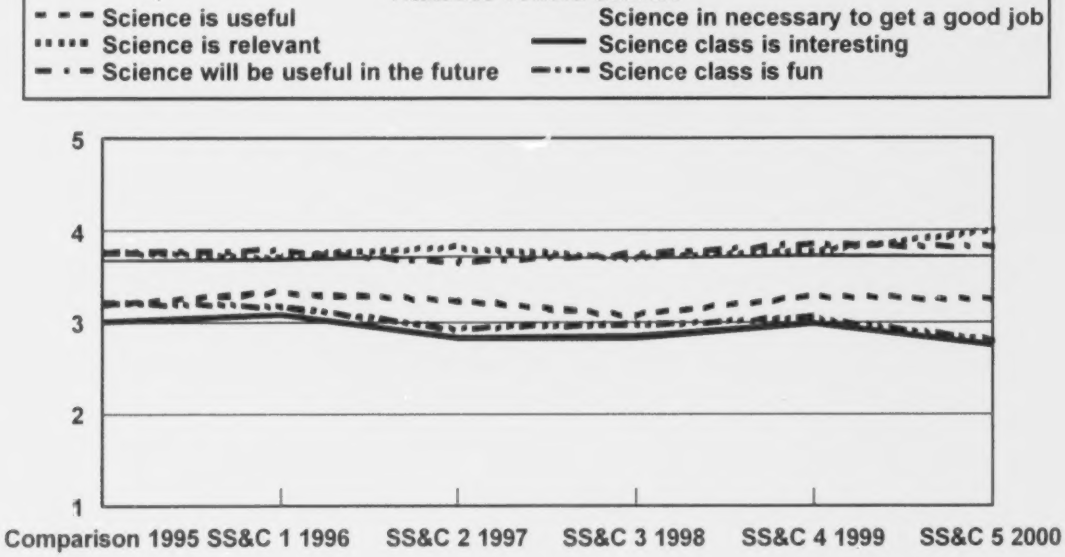


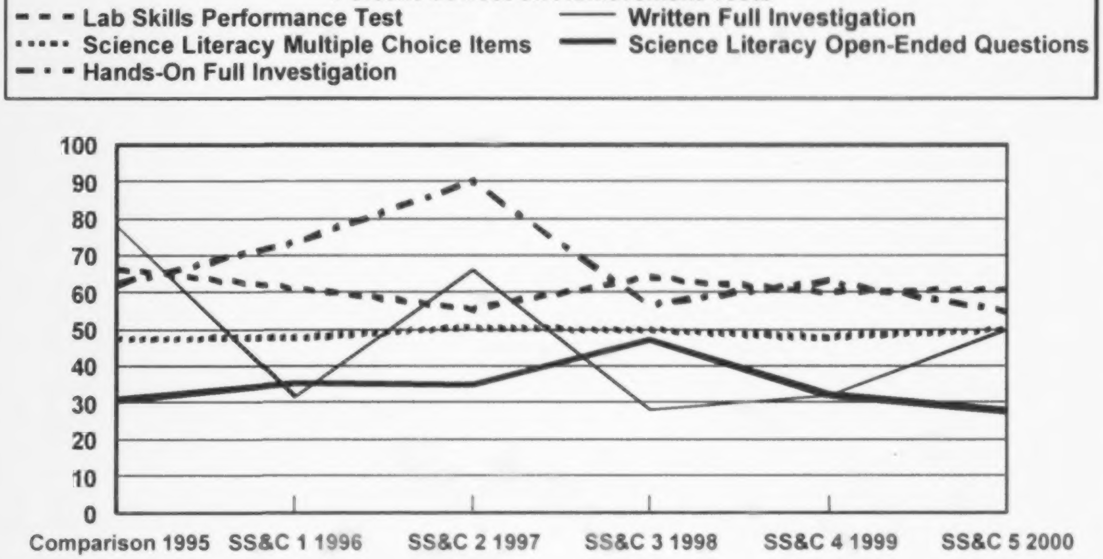
Figure 18
Student Questionnaire - California
Attitudes Toward Science



Achievement Measures

Several achievement measures at California High School revealed significant increases over the comparison group. The science literacy multiple choice scores were significantly higher than the comparison group in 1997, 1998, and 2000. The hands-on full investigation scores were significantly higher in 1997, and the open-ended scores were significantly higher in 1998. However, the written full investigation scores were significantly lower than the comparison group in 1996, 1997, 1998, and 1999. The lab skills performance test scores remained steady throughout the project. The positive changes on students' science literacy test scores appeared to correspond to the slow transition into SS&C methods that were observed in the classroom. The first year of SS&C was difficult, but after the teachers worked at the problem and got better organized, positive changes in achievement were observed on three of the five measures. The effect size chart revealed positive educationally notable changes for the hands-on full investigation (1996 and 1997) and the science literacy open-ended questions (1998). Negative educationally significant changes occurred for the written full investigation in all years and for the lab skills performance test (1997).

Figure 19
Achievement Scores - California
Student Means
Percent Correct on Achievement Tests



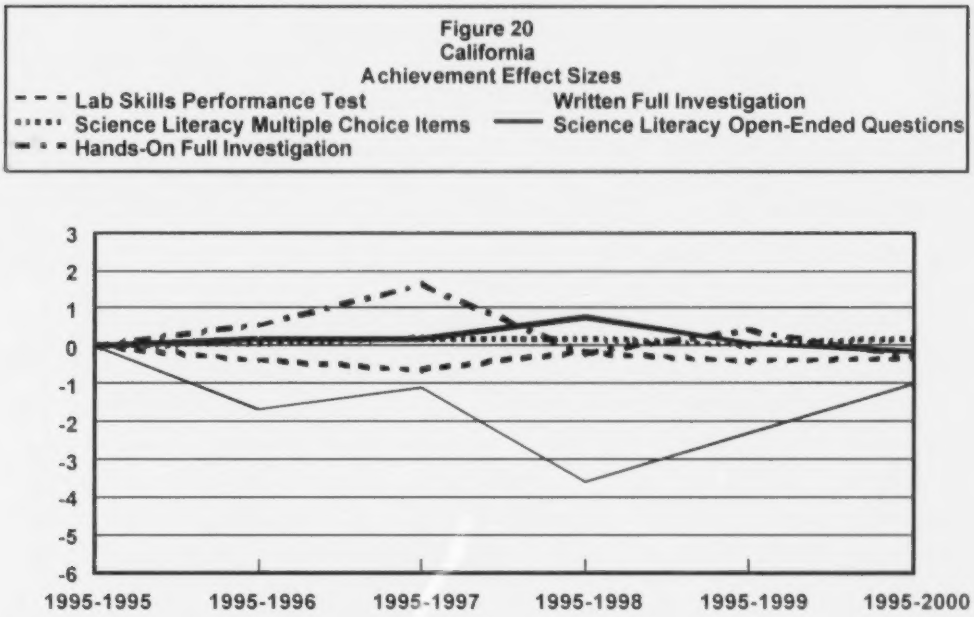


Figure 20
California
Achievement Effect Sizes

Summary of California High School

In summary, the implementation ofSS&C at California high school fits nicely with the model of curriculum implementation. SS&C was influenced by a variety of contextual and State factors. The intended SS&C curriculum was modified in light of the nature of the students. California High School had many students with limited English proficiency, and to accommodate these students the SS&C materials were modified. Fewer activities were included because the students worked at a slower pace and simpler readings were included. In addition, SS&C was modified because of the lack of resources and lab facilities. Like many urban schools they lacked expensive equipment and modified by using everyday materials for activities. The first enacted curriculum was essentially a simplified version of the intended curriculum. External factors played a role in subsequent revisions of SS&C. When the State of California mandated a new end-of-the-year physical science test it forced the teachers to alter the curriculum by shifting more physical science activities to the 9th grade. It also forced a shift back to more traditional assessment to help students prepare for the multiple choice test mandated by the State. The enacted curriculum ultimately stabilized and at of the end of the project was still being used by the 9th grade science teachers at California High School.

VII. IOWA HIGH SCHOOL

Detailed information about this site is contained in prior reports. What will be presented here is a description of the implementation effort at the site in terms of the nature of the schools and the students, the teachers involved in the implementation, the liaison person, the emotional and material support provided by the school, external pressures and the progress of the implementation effort.

Nature of the Community, School and Students

The high school was located in the suburbs of a medium-sized Iowa city. During the study, the surrounding suburban area consisted of moderate sized single family homes. There were multi-unit apartments within short distances from the school. New construction of single and multi-units was a common sight in the area. Older, established residential areas were located further away from the school, and in the city proper. The community ranged economically from low to upper middle class. The student population was almost entirely Caucasian with few African American, Asian American and Hispanic/Latino American students. The school had a high number of students, above 90%, who continued on to post-secondary school opportunities. The community and the population of the school were relatively stable over the course of the study. There were several large industries that had been in the community for many years, including John Deere Tractor, which were very active in providing technical and engineering jobs as well as support programs for the schools within the district.

The school was a 30-year-old two story brick/cement block building, with a science and math brick/cement block addition that was 10-years-old. The school contained an L-shaped floor plan. The building was very clean and neat with large plants greeting the students as they entered the school. Both inside and outside, the building was pleasant to look at and was well maintained. The school was located on a large tract of land, which the horticulture class used as an outdoor classroom. The school site included a state of the art track and field, and complete athletic facilities, including a swimming pool. The science classrooms were grouped together in the new addition, located on both the first and second floors. Class sizes over the years ranged from 18-25. Classes were offered on a 45-minute period schedule. The students were generally polite and behavior problems were few. The attendance rate was above 95%, and students seemed to be involved in and generally accepting of their school programs.

Nature of the Teachers

There were seven science teachers in the school each of the data collection years with two teaching 9th grade. All of the science teachers were dedicated to making the science experience the best they could for their students. The two teachers who attended the initial training taught the SS&C course for the first two years, and then one new teacher and the next year another, were hired that took over the 9th grade teaching. The prior teachers mentored these new teachers. The teachers felt they were doing a good job prior to the implementation of the SS&C project, but also were willing to try new things if it would help the students.

Nature of the Liaison

There were two different liaison teachers during the period of the study. Both individuals were also in turn the heads of the science department. The second liaison assumed the duties after the original liaison retired. The liaison teachers did not teach SS&C but they both were very supportive of the teachers who were actively involved with the project. Both individuals answered questions and provided adequate support for supplies and for paid release time to work on the curriculum. Both liaisons believed that the course was really in the hands of the 9th grade teachers teaching the SS&C course.

Support Provided by the School

There were two principals during the period of this study. Based on the interviews, both principals appeared to be concerned about providing students with a quality education, one that prepared them for the diverse opportunities that they would face after leaving high school. Both principals also appeared to be concerned about enhancing the reputation of the school. The school held high standards for academic achievement and was a proud member of the local community.

The laboratories were reasonably well equipped with most of the major equipment being somewhat old. The teachers purchased consumable supplies and materials as needed for the science program, using science budget funds. Major pieces of equipment were purchased on a need basis. The school provided summer salary for the teachers for several years in order to work on consolidating and improving the 9th grade science curriculum.

External Pressures

There were no significant external pressures on the school. The Statewide assessments remained the same, and no serious financial or enrollment changes occurred.

Progress of the Implementation

Teachers who were trained during the summer used the curriculum the first year. These teachers taught SS&C the next year, and then one new teacher was hired and then a second teacher was hired for the 9th grade. The two new teachers are now in charge of the 9th grade course. The originally trained teachers played a key mentoring role. The curriculum contained much of the original SS&C material but was consolidated, added to and rearranged to better fit the school and students. The last year of the study the school used an integrated science textbook as well as the SS&C materials. The administration, as well as concerned parents, supported the addition of the textbook. The integrated science course is required for all ninth graders except a small group of honors students.

Based on the teachers' reports of what topics were covered each year, the first year of SS&C showed an increase in the time spent teaching physics and a decrease in the time spent teaching biology. After that first year the amount of time spent teaching the four science areas of physics, chemistry, earth science and biology were somewhat balanced around ten weeks each, with earth science showing the most fluctuation. (See Table 53 in the Appendix.)

Iowa High School Learning Environment Measures

The learning environment was assessed in four different ways. The students and teachers completed a questionnaire that asked about what activities occurred in the class. These activities were grouped into factors. On the student questionnaire there were four factors: inquiry, group work, traditional and other. On the teacher questionnaire there were two factors: inquiry and traditional. The introduction to the individual site sections describes these factors and their analyses in detail. The third measure was observations of the classes by external observers. These observations allowed the class activities to be categorized into student-centered, teacher-centered, group, administrative and other. The fourth measure was a learning environment inventory with several scales related to the classroom psychosocial environment, which was completed by the students.

When forced into percent of total class time categories, the student questionnaire data showed a significant increase in group activities that continued throughout all the years of the project. This increase was accompanied by a significant decrease in independent inquiry activities. Overall, the students rated the frequency of inquiry activities as about once a week to several times a week and the frequency of group activities as several times a week. The frequency of traditional activities was rated as less then once a week.

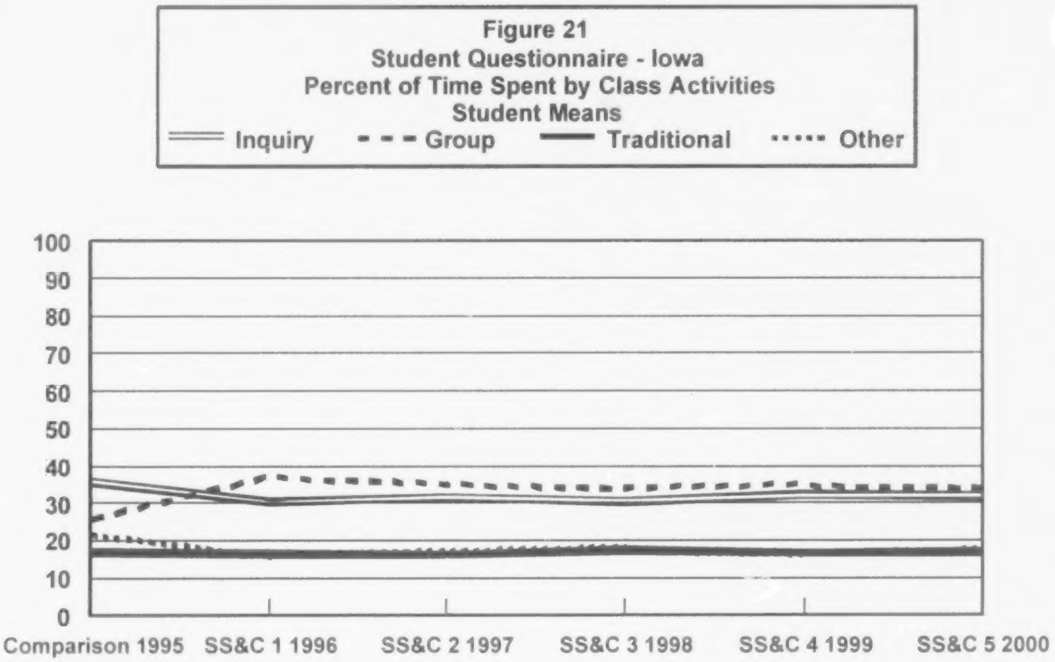


Figure 21
Student Questionnaire - Iowa
Percent of Time Spent by Class Activities
Student Means

The teacher questionnaire data were not forced into percentages like the student data. Only the frequencies are presented below. There was one significant change, an increase in traditional activity the first year but then returned to original levels. The 1997 data are missing. The teachers rated the traditional activities as occurring slightly less than once a week and inquiry activities as increasing over the course of the study, although not significantly, from about once a week to more than several times a week.

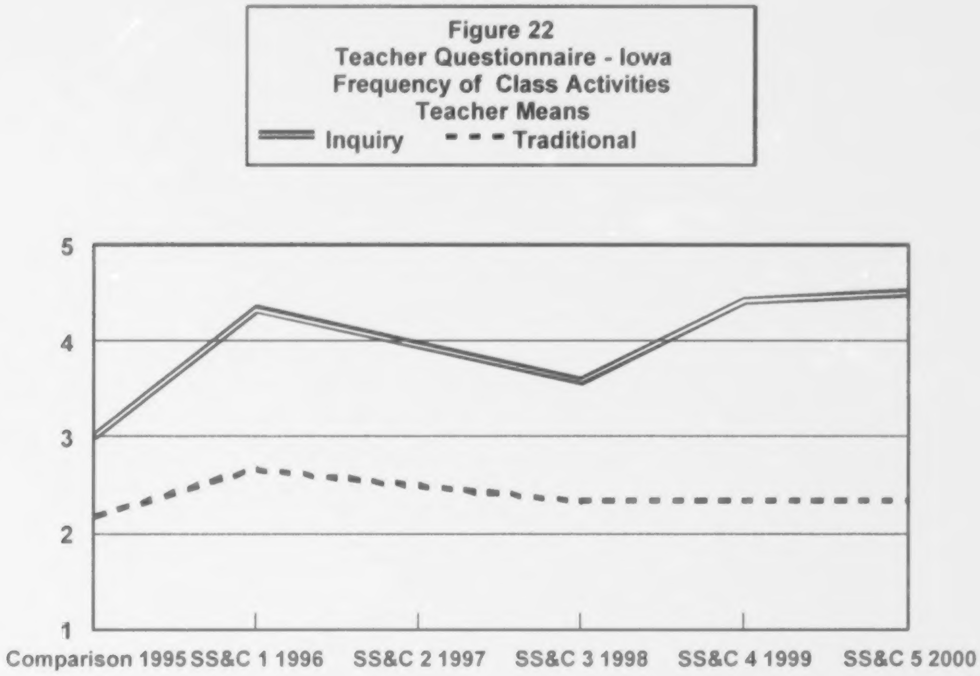


Figure 22
Teacher Questionnaire - Iowa
Frequency of Class Activities
Teacher Means

During the last three years of the project, questions were added to the teacher questionnaire. The teachers were also asked to rate the percent of time they spent in whole class activities, group activities, and individual activities. After doing these ratings, the teachers then described what happened within each category. These data showed that in 1999 there was an increase in individual activities and a decrease in group activities, but that these changed back to original levels in 2000. Individual hands-on activities showed increases over the three years. (See Tables 60-62 in the Appendix.)

The classroom observation data showed a significant increase in the time spent displaying student-centered teaching during the first SS&C year, which was maintained through all years. The time spent displaying student- and teacher-centered teaching dropped significantly during the first SS&C year and remained lower than the comparison year all years. The percent of time spent in student-centered teaching increased from about 10% to 40% the first year and then increased again to about 60% the last year.

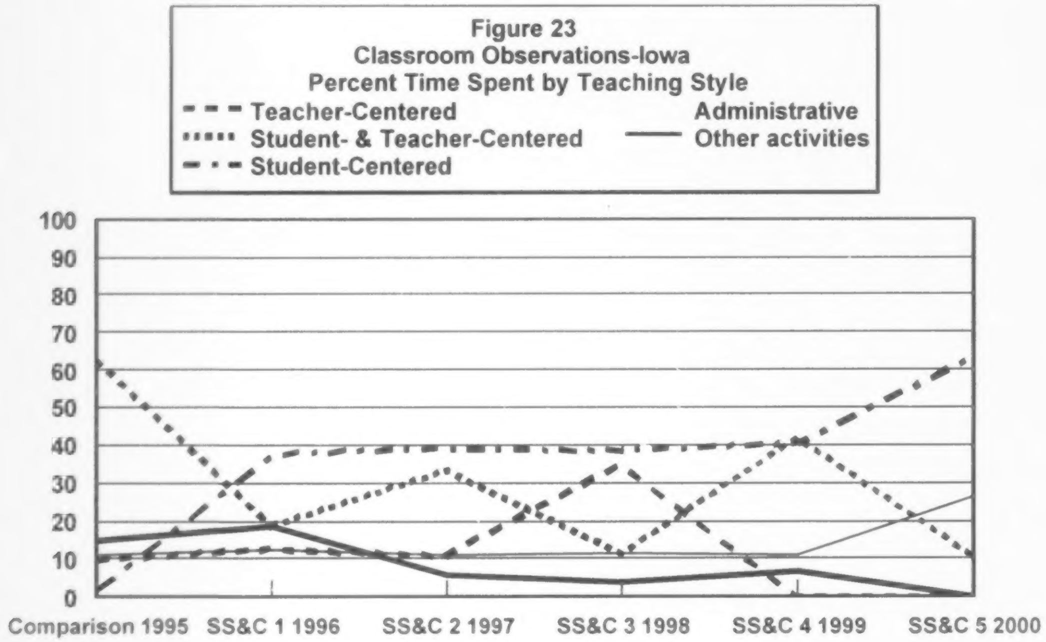


Figure 23
Classroom Observations-Iowa
Percent Time Spent by Teaching Style

As a second look at the classrooms, the observation forms asked the observer to rate the level of student involvement and the type of instruction. These ratings showed no significant changes but there was a trend toward more student involvement and more mixed instruction.

The learning environment inventory showed the involvement, relevance and critical voice scales significantly rose together after the second year of SS&C and remained high for the rest of the years except involvement the last year. The scale scores for these three items spanned from sometimes to often. Sequencing increased significantly the first year but then returned to and remained at initial levels. Difficulty decreased significantly the third and fourth years and then returned to comparison year levels the final year. In all years the experimenting scale was significantly higher than the comparison year.

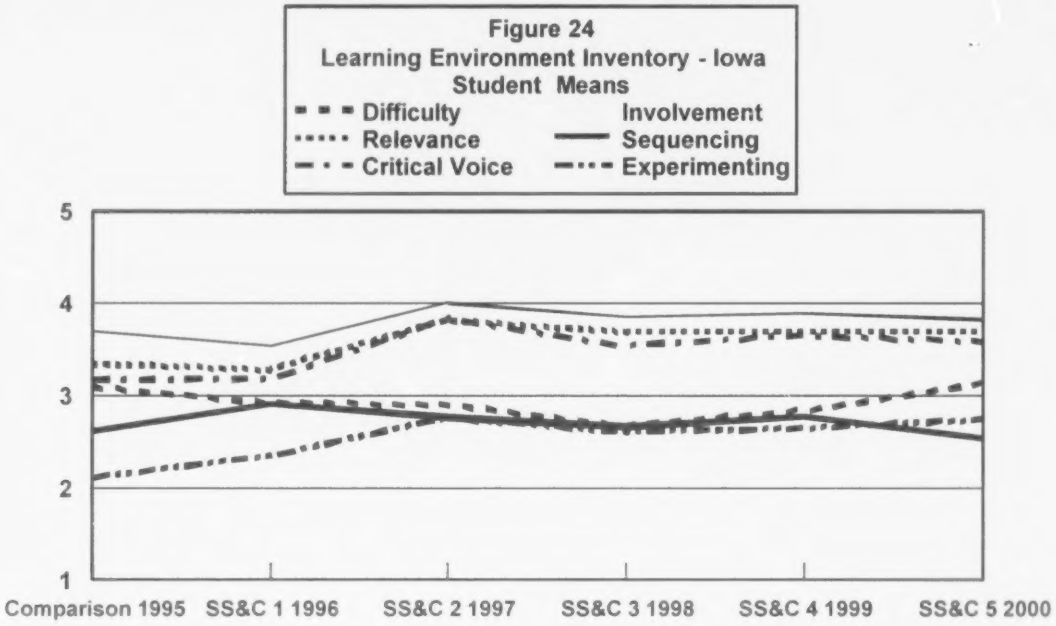


Figure 24
Learning Environment Inventory - Iowa Student Means

Overall the changes in classroom learning environment documented by the various measures indicated that the classrooms moved toward more inquiry-based student-centered learning that was perceived as being more relevant, more involving and as allowing more experimentation. These changes reflected the implementation of the reform, which began well and continued to be maintained throughout the course of the study.

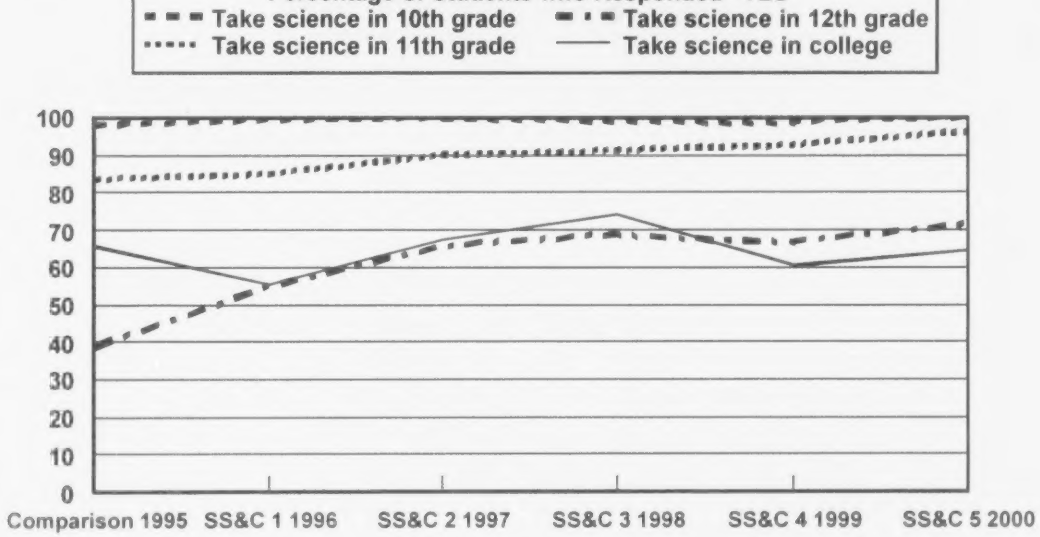
Iowa High School Student Outcome Measures

The student outcome information can be grouped in two ways. The inclination of students to continue studying science and student motivation and attitude toward science is one group, and student achievement on the lab skills performance test, science literacy multiple choice items, full investigations, and science literacy open-ended items is the second.

Attitude & Motivation Measures

Little change was seen in the inclination of students to take science courses in 10th and 11th grade. This was probably due to the school's graduation requirements. There was, however, a significant rise in inclination to take 12th grade science that remained all years of the study. The "totally awesome experience" item was significantly higher than the comparison year the first year of SS&C and throughout the rest of the study remained high. The "activities make you want to take more science," "science class is motivating," and "had a 'totally awesome' experience" items were significantly higher than the comparison year in 1997 and remained there. The attitude data generally showed significant increases starting the second year of SS&C implementation. Most of these increases remained for the course of the study.

Figure 25
Student Questionnaire - Iowa
Inclination to Continue Studying Science
Percentage of Students who Responded "YES"



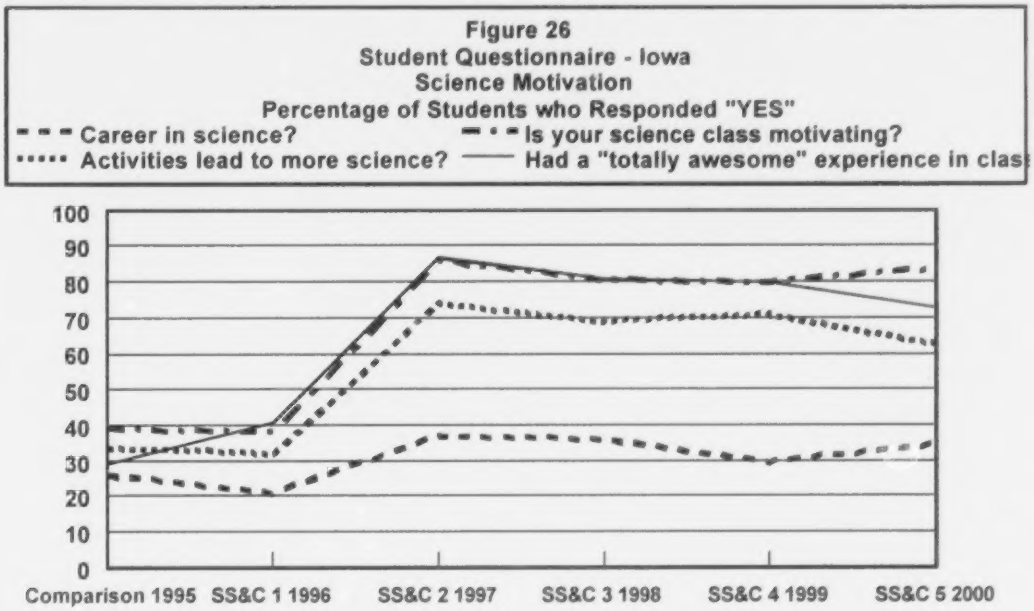


Figure 26
Student Questionnaire - Iowa
Science Motivation
Percentage of Students who Responded "YES"

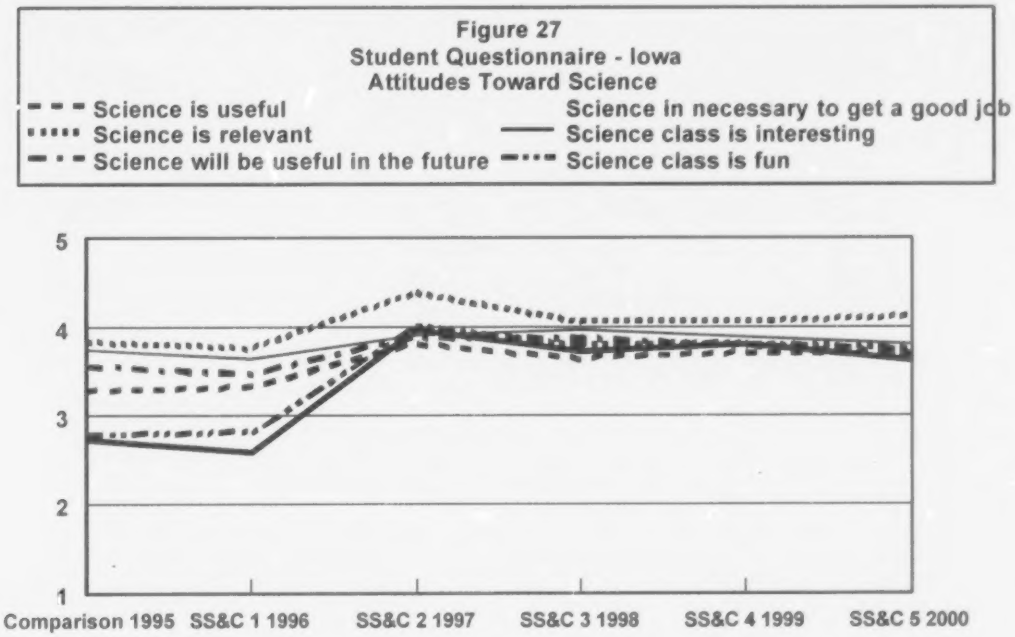


Figure 27
Student Questionnaire - Iowa
Attitudes Toward Science

Achievement Measures

Some significant changes were seen in the achievement data. Students scored significantly lower on the science literacy multiple choice test all years of the study. They scored significantly higher on the lab skills performance test only the last year of the study but had been showing consistent improvement in their scores since the second year of SS&C. The scores on the science literacy open-ended items showed significant decreases from the comparison year the first, fourth, and fifth years of SS&C. The other scores varied but did not show significant changes. The effect size chart revealed positive educationally notable changes for the hands-on full investigation. Negative educationally notable changes occurred for the science literacy multiple choice and open-ended questions.

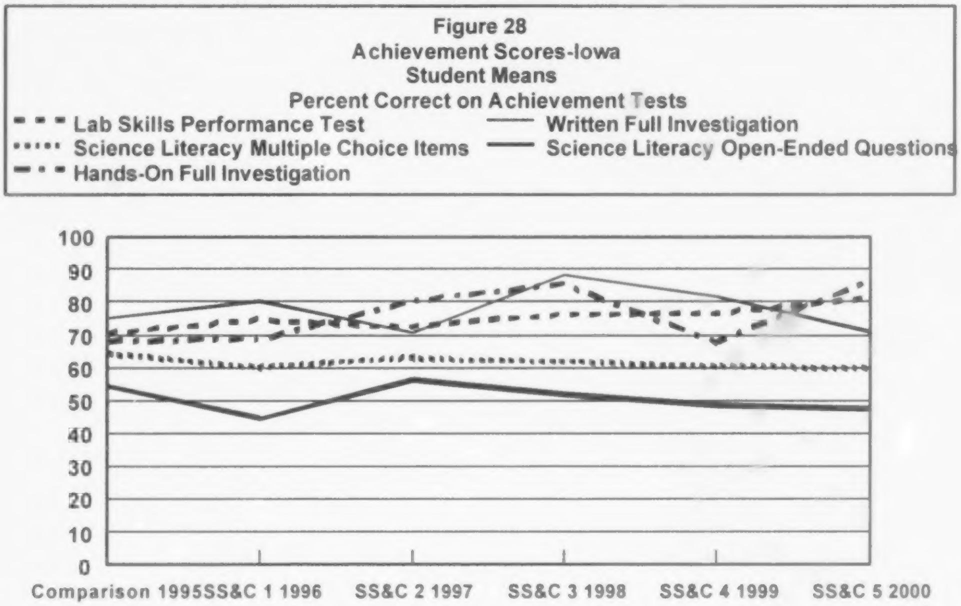
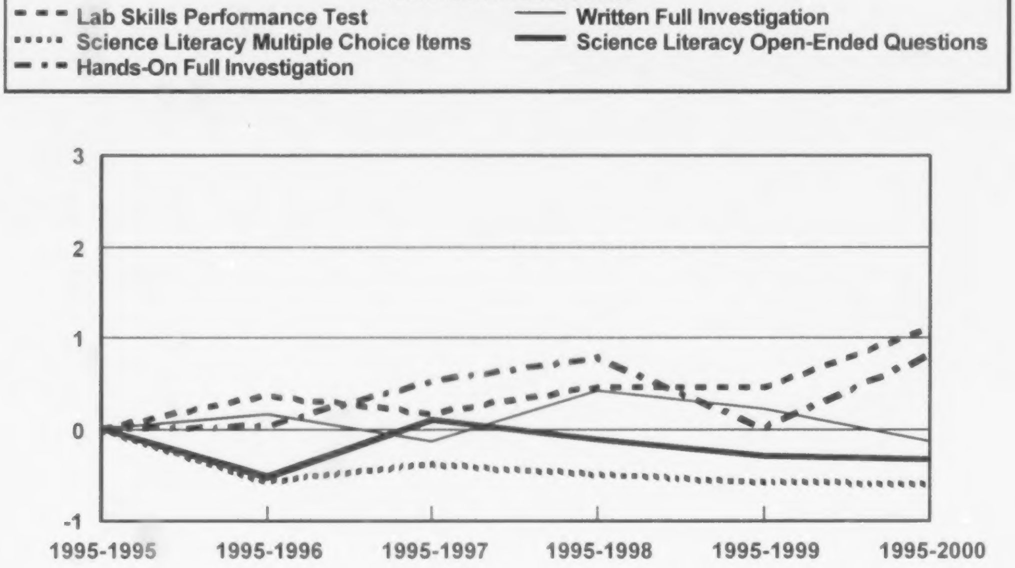


Figure 28
Achievement Scores-Iowa
Student Means
Percent Correct on Achievement Tests

Figure 29
Iowa
Achievement Effect Sizes



Summary of Iowa High School

In summary the Iowa High School implementation was complete. Considering their experience in light of the proposed model for teacher enhancement highlights several crucial components. The school was well prepared to implement the curriculum. It was well supplied with the equipment necessary to support the curriculum, the teachers were well qualified, and the administration, i.e., the principal and the department chair-liaison teacher, was supportive. The two teachers were somewhat skeptical about the value of the new curriculum but were willing to see what it had to offer. The first enacted curriculum was very close to the intended curriculum with slightly less student-centeredness than the curriculum called for. The teachers felt the curriculum had promise and modified it for their use the second year, bringing in more of their own activities and modifying the ones they felt did not work as well as they might. The classes became more and more student-centered over the years. The teachers were given extra time each summer to work on the curriculum. This pattern of incremental improvement continued throughout the course of the evaluation project. After several rounds of improvement the initial teachers passed the course on to new teachers one at a time, and these new teachers were engaged in the incremental improvement process.

VIII. MONTANA JUNIOR HIGH SCHOOL

Detailed information about this site is contained in prior reports. What will be presented here is a description of the implementation effort at the site in terms of the nature of the community, school, and the students, the teachers involved in the implementation, the liaison person, the emotional and material support provided by the school, external pressures and the progress of the implementation effort.

Nature of the Community, School and Students

During this study, Montana Junior High School was an 8th and 9th grade junior high school located in a small city in the Rocky Mountains of northwestern Montana. The school itself was a traditional two-story brick building. It was clean and well maintained, and all indications were that the school was well funded and well equipped. The atmosphere of the building was very upbeat, and the staff and students were quite friendly and welcoming. The school in many ways had a typical junior high feel; it was very active and social. At Montana Jr. High there were eight class periods during the day, each lasting approximately 50 minutes. All of the science classrooms were located in one area of the building. The school had over 500 9th graders, who were predominately middle-class and Caucasian. The majority of students were college bound and appeared motivated about learning and doing well in school.

Nature of the Teachers

There were two 9th grade science teachers who were involved in the SS&C program from the very beginning. Only one of these two teachers attended summer SS&C workshops. They were both veterans that had been in the field for over 15 years. They worked hard together at planning the SS&C lessons and gathering all the equipment necessary to implement the SS&C activities. These two teachers, along with one other teacher at the school, taught all of the sections of SS&C for the first three years of the project. At that time, one of the lead teachers retired. In addition, the other lead teacher, who also served as department chair, decided to rotate new teachers into SS&C. As a result, in the fourth year of the project all of the teachers were new to SS&C. The lead teachers organized the materials so well that transitioning in new teachers was quite smooth. They scheduled classes so that most SS&C classes met at a different time, and as a result they could share materials. The materials were placed on a cart. One teacher used them and then passed them on to the next teacher. This also allowed the first teacher to pass on tips to the other teachers and to discuss what went well and what needed modification.

Nature of the Liaison

The liaison at this site was the high school science department chair and chemistry teacher in the same district as the junior high. He did not teach SS&C, but served as an advisor to the implementation and development of activities. He was extremely supportive of SS&C and served as one of the developers of chemistry activities for the national project. During the first year of the project he went to the junior high school several afternoons a week to meet with the two lead teachers about implementing SS&C and refining activities. In subsequent years he visited the junior high at least monthly and as needed by the teachers. Through his position as department chair he was also able to provide money for new equipment as needed by the teachers, and a vision of how the 9th grade SS&C activities fit into the district science scope and sequence curriculum.

Support Provided by the School

The principal at Montana Jr. High School was very supportive of SS&C and believed that the teachers did an excellent job of implementing the curriculum. Based on the increased student enrollment in SS&C the principal was quite pleased with how the course was received and believed the program succeeded and served students very well. The principal also thought the teachers did an outstanding job of implementing SS&C.

External Pressures

The primary external pressure on the SS&C program was the tension between teachers and the principal regarding the number of science course offerings. The principal felt strongly about consolidating science course offerings down to one or two options in order to make it easier to schedule classes. At the same time, the teachers felt strongly about offering many different options to the students including biology, SS&C, basic SS&C, and honors earth science. Ultimately, enrollment in SS&C was left up to students and parents. At first, many parents were concerned about converting all courses to SS&C. SS&C classes were therefore started as an optional alternative to taking biology or earth science. Over the years, interest and enrollment in SS&C increased as more and more students and parents saw the impact on students. At the end of the project, the principal still desired a complete conversion to SS&C, while the teachers wanted to allow students and parents to choose from different course options.

Progress of the Implementation

In the first year Montana Junior High offered seven sections of SS&C, two were low-level SS&C, and five were regular SS&C. Both tracks did essentially the same activities; however, the low-level classes did not go into as much depth and took extra time to discuss each activity. By the end of the five year project, the enrollment in SS&C had increased to ten sections of SS&C. Throughout the project the science department continued to offer biology and honors earth science for their advanced students who did not want to take SS&C.

All of the 9th grade teachers were required to teach SS&C at some point. The department chair had everyone teach SS&C on a rotating basis so that everyone had a common experience and ownership over the curriculum. Montana Junior High School used the SS&C curriculum as intended throughout the entire project. They only made minor modifications to help the activities fit their equipment. In addition they used the original 9th grade sequence provided by SS&C. The only aspect of the curriculum that they did not use was the readings. Prior to SS&C they used labs and believed in hands-on science, but with SS&C they gave students much more control and input into doing science. In the past, labs were traditional cookbook-style labs with all the procedures dictated to students. The more inquiry-oriented SS&C methods opened their eyes to how much more students could do. At the end of the five year project, SS&C was still being implemented as intended with all indications that the science department would continue offering SS&C well into the future.

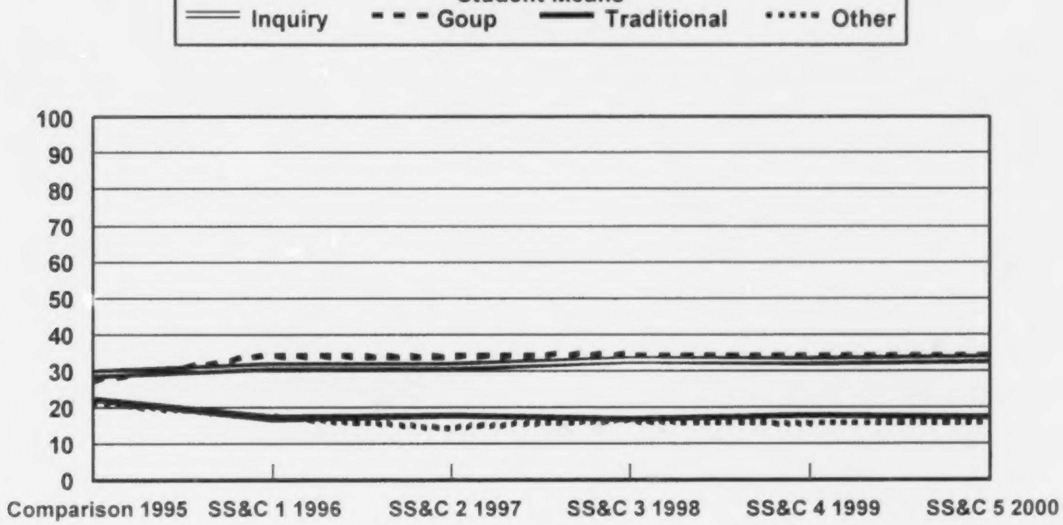
Based on teachers' reports of what topics were covered each year, the first year of SS&C included more physics, chemistry and biology, and less earth science. Prior to SS&C most students took earth science in 9th grade, and the change to SS&C resulted in balanced instruction in all four areas. (See Table 79 in the Appendix.)

Montana Junior High School Learning Environment Measures

The learning environment was assessed in four different ways. The students and teachers completed a questionnaire that asked about what activities occurred in the class. These activities were grouped into factors. On the student questionnaire there were four factors: inquiry, group work, traditional, and other. On the teacher questionnaire there were two factors: inquiry and traditional. The introduction to the individual site sections describes these factors and their analyses in detail. The third measure was observations of the classes by external observers. These observations allowed the class activities to be categorized into student-centered, teacher-centered, group, administrative and other. The fourth measure was a learning environment inventory with several scales related to the classroom psychosocial environment, which was completed by the students.

The student, teacher and observation data all supported the conclusion that the learning environment at Montana Junior High School was significantly changed throughout the entire SS&C project. When forced into percent of total class time categories, the student questionnaire results showed there was a significant increase in the percentage of time teachers engaged in both inquiry and group activities, and a significant decrease in the percentage of time teachers used traditional activities. On specific questions about class activities the students indicated that from the comparison year to all SS&C years there was a significant increase in the frequency of having students do experiments with other students, share the results of experiments, suggest hypotheses (except in 1997), and work in groups.

Figure 30
Student Questionnaire - Montana
Percent of Time Spent by Class Activities
Student Means



The teacher questionnaire data were not forced into percentages like the student data. Only the frequencies are presented below. There was a significant increase in the use of inquiry during all but one of the SS&C years.

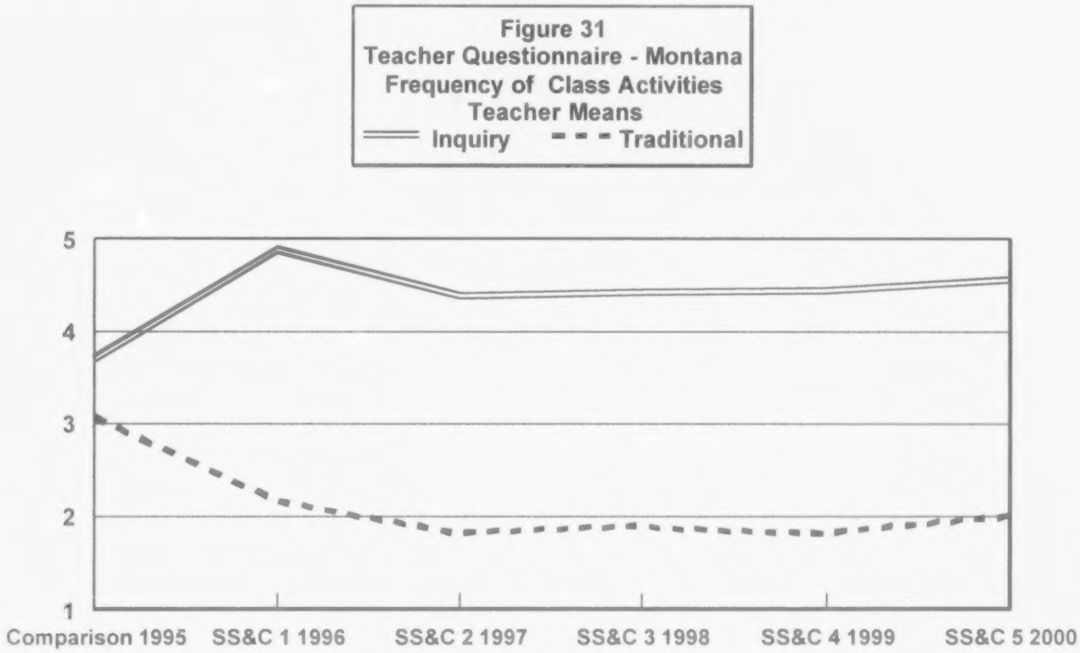


Figure 31
Teacher Questionnaire - Montana
Frequency of Class Activities
Teacher Means

During the last three years of the project, questions were added to the teacher questionnaire. The teachers were asked to rate the percent of time they spent in whole class activities, group activities and individual activities. After doing these ratings the teachers then described what happened in each category. Teachers' views of the percent of time on group or whole class activities showed that during all years teachers used group activities more than whole class activities. Hands-on activities dominated the group instruction, while class discussion dominated the whole class instruction. (See Tables 86-88 in the Appendix.)

The class observations also showed that the learning environment changed significantly with the use of SS&C. During the comparison year observations of classes indicated that teacher-centered activities dominated instruction (approximately 70% of class time). During the first year of SS&C teacher-centered activities dropped down to 15% of the class time while student-centered activities increased to over 50% of the class time. Student-centered instruction dominated the instruction over all years of the project.

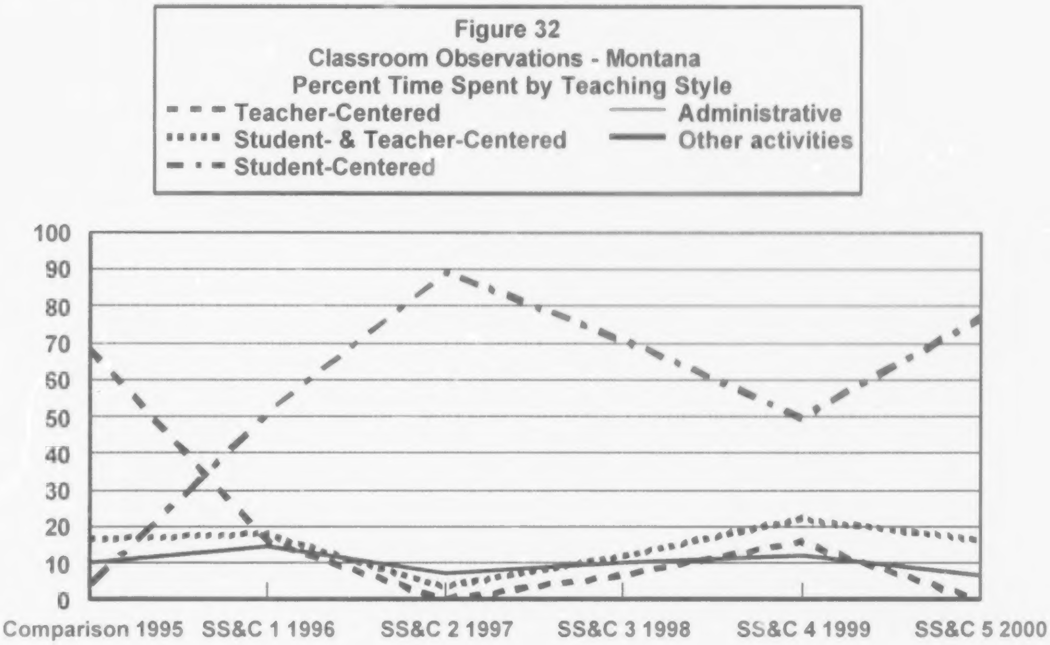


Figure 32
Classroom Observations - Montana
Percent Time Spent by Teaching Style

As a second look at the classrooms, the observation forms asked the observer to rate the level of student involvement and type of instruction. The ratings of student involvement showed no significant changes over the project; however, there was a significant increase towards more inquiry-oriented instruction during all years of SS&C.

The learning environment inventory results also showed a significant change in the learning environment. There was significant increase in the use of an inquiry sequence during all SS&C years, a significant increase in students' critical voice and the extent to which students experimented in two of the five years. There was a significant decrease in students' perception of the difficulty of classes in all SS&C years except the last one.

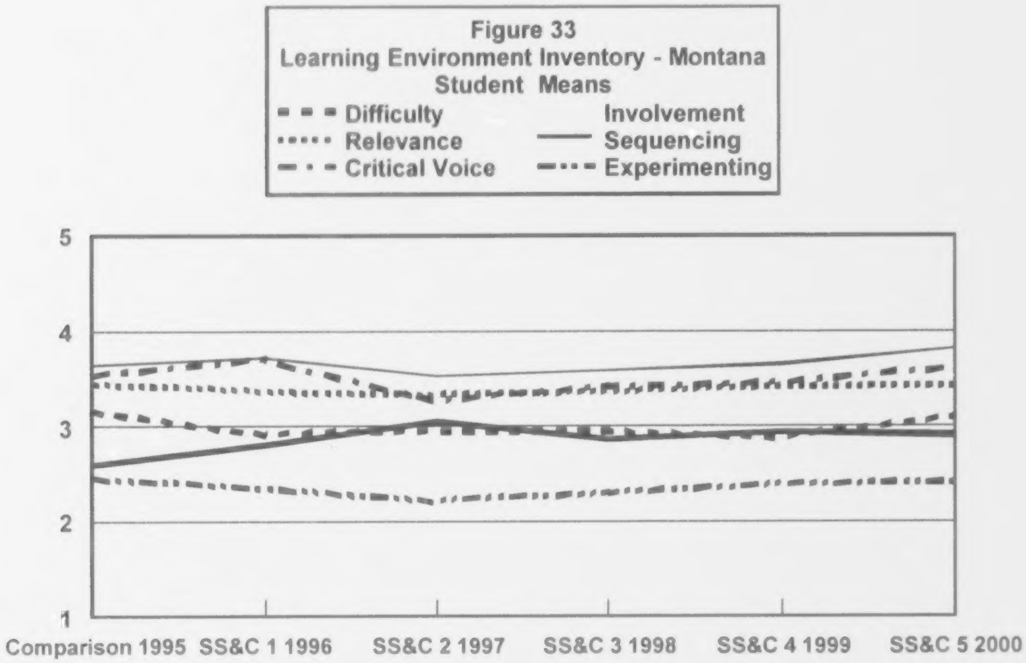


Figure 33
Learning Environment Inventory - Montana
Student Means

The changes in the learning environment directly corresponded to the implementation of SS&C at Montana Junior High School. The two lead teachers diligently implemented SS&C and created a kit-based system of SS&C activities where new teachers could take over and implement SS&C with the support of an experienced teacher. The system appeared to have resulted in a consistent implementation of SS&C and consistent changes in the learning environment during each of the years of the project.

Montana Junior High School Student Outcome Measures

The student outcome information is grouped in two ways. The inclination of students to continue studying science and student motivation and attitude toward science is one group and student achievement on the science literacy multiple choice items, science literacy open-ended items, lab skills performance test, and written full investigations is the second.

Attitude & Motivation Measures

Despite the dramatic changes in the learning environment at Montana Junior High School, there were slight or no changes in students' attitudes and motivation. The inclination to study science in the future appeared to remain constant. Only very minor changes were noted in students' attitudes toward science and motivation. In the first year only there was an increase in students' perceptions that their science class was motivating, and in two of the SS&C years there was an increase in having a totally awesome science experience. No changes were found in students indicating that they intend to study more science in 10th, 11th, 12th grade or in college. It appeared that even though the teachers used a more inquiry-oriented approach to teaching science, it did not have a significant impact on student attitude or motivation. Scores on these measures were positive during the comparison year and remained positive during the SS&C program.

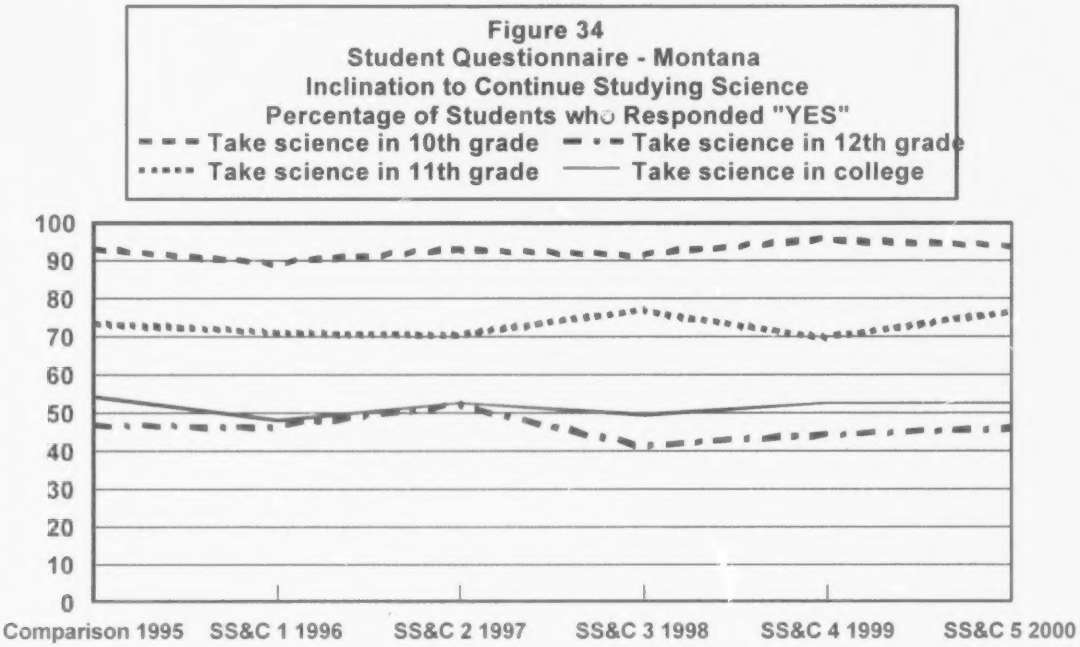


Figure 34
Student Questionnaire - Montana
Inclination to Continue Studying Science
Percentage of Students who Responded "YES"

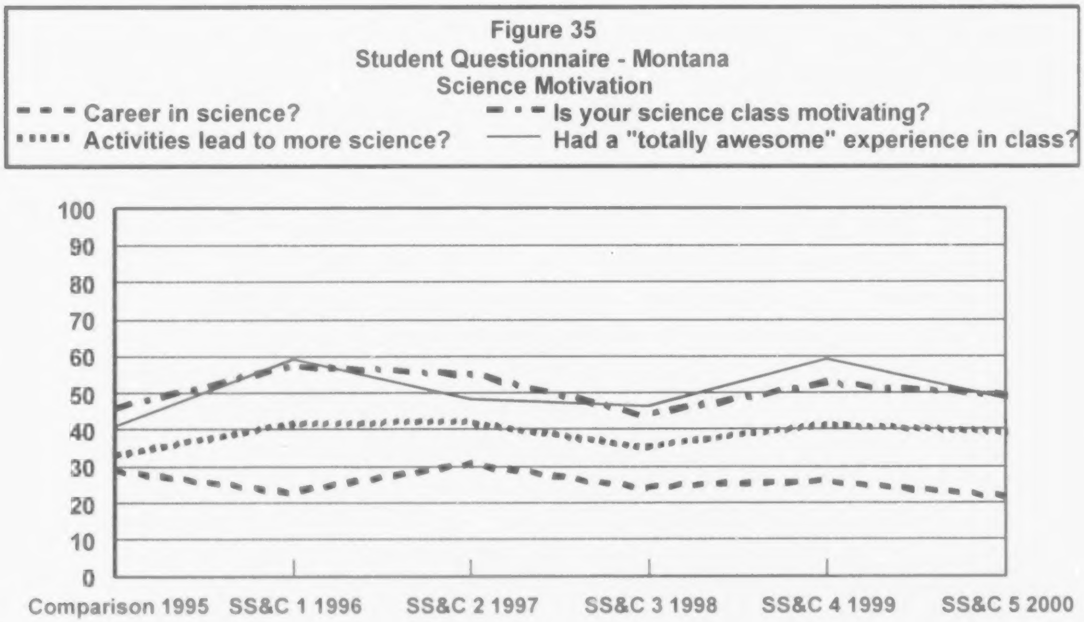


Figure 35
Student Questionnaire - Montana
Science Motivation

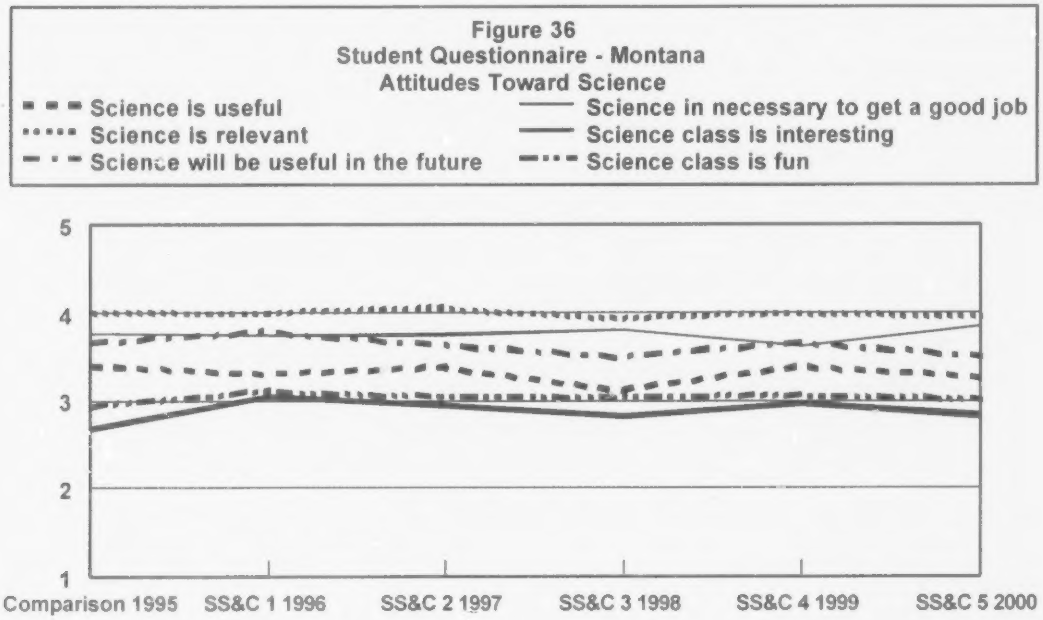


Figure 36
Student Questionnaire - Montana
Attitudes Toward Science

Achievement Measures

No significant increases were found on the science literacy multiple choice items. For two years, significant decreases were found on the open-ended science literacy items. The lab skills performance test scores during four of the five years of the SS&C project were significantly higher than the comparison group. Differences were also found on the hands-on full investigation test. In three of the five years the SS&C group scored significantly higher on the hands-on full investigation tests than the comparison group. SS&C students also scored significantly higher on the written full investigation test during only one year. The differences in hands-on test scores appeared to be due to the more inquiry-oriented science teaching methods at Montana Junior High School. It appeared that the more hands-on, inquiry approach to teaching science positively affected students' laboratory skills. The effect size chart revealed positive educationally notable changes for the hands-on and written full investigations in all years but one and for the lab skills performance test in all years except for one.

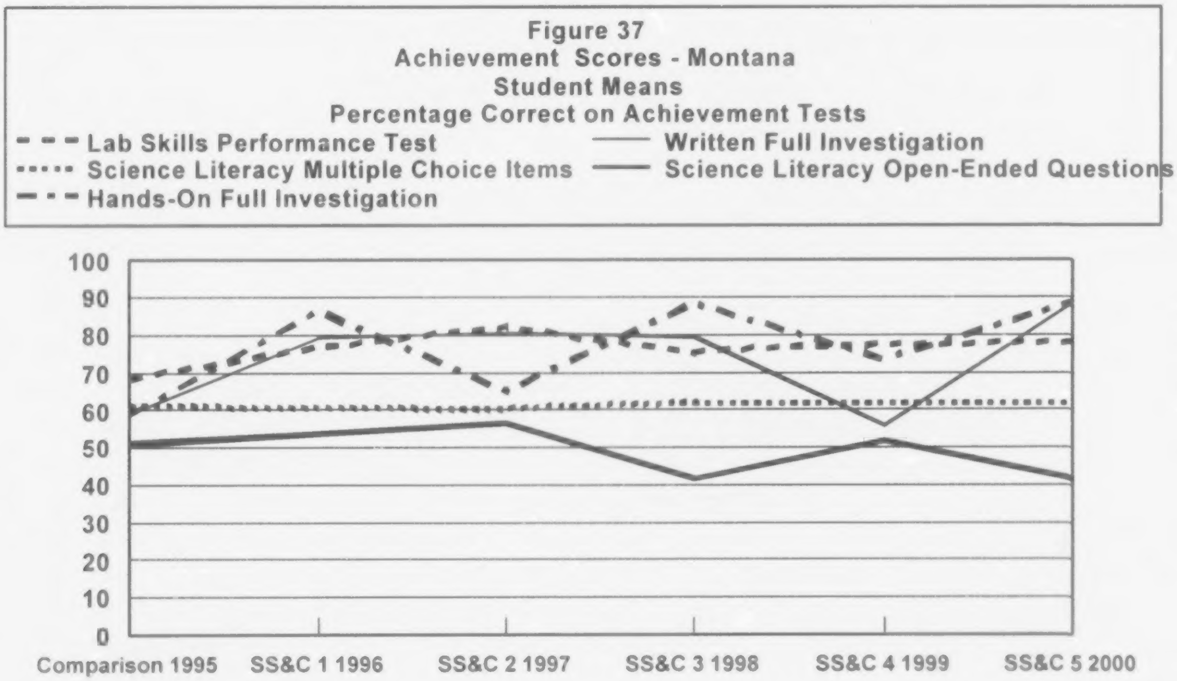
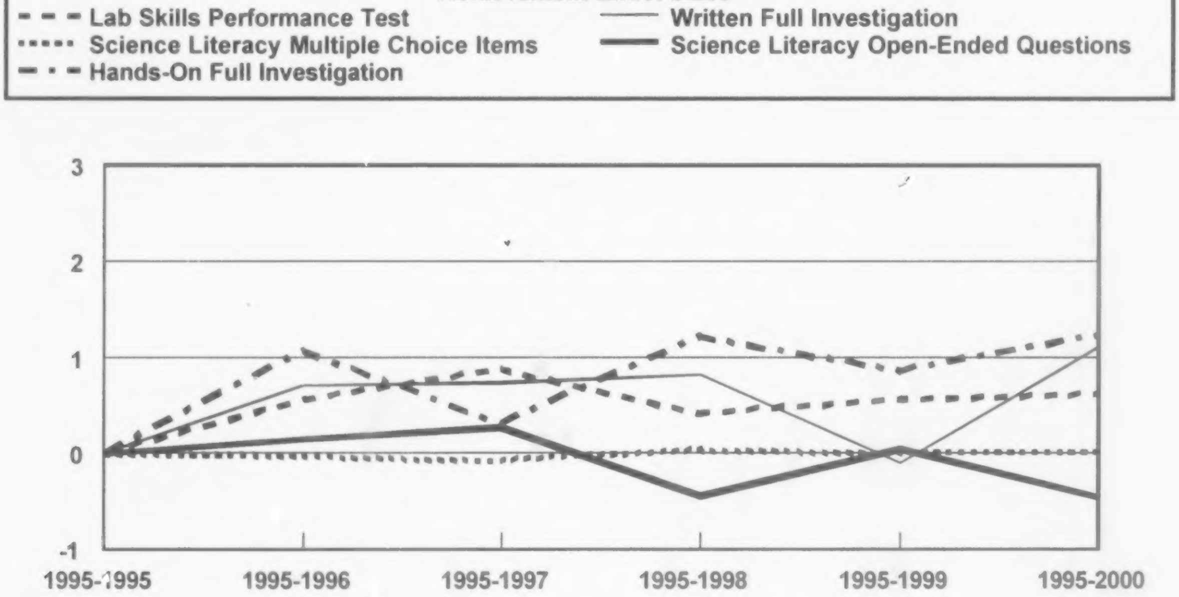


Figure 37
Achievement Scores - Montana
Student Means
Percentage Correct on Achievement Tests

Figure 38
Montana
Achievement Effect Sizes



Summary of Montana Junior High School

In summary, Montana Junior High School made a very careful and concerted effort to implement SS&C. The initial intended curriculum was only slightly modified to fit the context. Even though NSTA intended all 9th grade classes to use the curriculum, at Montana Junior High the teachers and administrators thought that students and parents should have a choice between the reform curriculum and the traditional courses. As a result, they added SS&C to their list of possible courses, rather than using it to replace courses. The curriculum was also slightly modified to fit the resources provided by the school. For many activities the science department did not have the necessary equipment, so they modified the activities to fit the resources. The two 9th grade teachers and the liaison worked diligently to implement SS&C as close to intended.

Parents, students, teachers and administrators positively viewed the first enacted curriculum. Since parents and students had a choice about which class to take, the perceptions of parents and students were critical to the continued use of SS&C. As it was, the student outcomes were perceived as positive, and interest and enrollments increased during the second year of SS&C. External pressures played a very small role in the SS&C curriculum. The State of Montana did not institute any mandates in curriculum and assessment, and overall gave schools and districts a lot of freedom in this area. This stability allowed the teachers to organize materials for each activity, share the same materials, and in the end develop a very complete curriculum that could be consistently implemented by different teachers.

IX. NEW YORK HIGH SCHOOL

Detailed information about this site is contained in prior reports. What will be presented here is a description of the implementation effort at the site in terms of the nature of the community, school, and the students, the teachers involved in the implementation, the liaison person, the emotional and material support provided by the school, external pressures and the progress of the implementation effort. The numbers of students participating at this site was small initially and decreased as the study continued so the quantitative results should be viewed with caution.

Nature of the Community, School and Students

During the study, New York High School was in a lovely setting with extensive grounds including a pond and surrounding hills and trees. The site housed both the middle school and the high school. The high school building was adequate and generally clean but not classy, new or "tip-top". Stairs had broken edges, doors were worn, and connections between buildings had a long term temporary feel, etc. Science classrooms, however, were full of materials, posters, equipment, and projects.

The community was mixed with very high-income homes and very low-income housing developments. The low-income segment of the community was growing fast. Most of the low-income group is Hispanic/Latino American. There was also a stable, long-term resident population of African Americans. Most of the people worked in New York City. The school was well supported by both parents and businesses in the community.

Because of the New York State Regents' course programs, SS&C had only been available to a limited number of students at the high school, approximately 60 students per year. These were the students who did not enroll in the New York Regents courses – those who were ESL, those with low levels of motivation or those who were academically challenged in other ways. The classes over the years were kept small (e.g., 15 students) so that individual attention could be provided. All science classes were 50 minutes per day with two extra periods a week for laboratory experiences. Freshmen beginning in the 1999-00 school year were required to take at least one Regents science course to graduate.

Nature of the Teachers

There were approximately ten teachers in the science department over the data collection years. The teachers rotated through teaching 9th grade science so a different set of one to four teachers were involved each year. While SS&C was being used, teams of four teachers representing the different content areas (earth, physical, chemical and life sciences) taught the course. A total of five teachers with a mix of experience teaching attended the training offered during the summers. Before becoming involved in the SS&C project, the teachers were content with their teaching styles and abilities. Although most were willing to try new things, the experienced teachers felt that they were already close to being master teachers. The new teachers involved in the reform were interested in learning new techniques. They did not have existing styles to change, and their recent pre-service training was related to the standards. This impression was supported by the fact that the school had very high standards for hiring and keeping science teachers, and the department chair was heavily involved in national science reform.

Nature of the Liaison

The liaison for this site was also the science department chairperson. Although he did not teach SS&C initially, he did teach it the second year. He had a strong personality and was committed to having the school offer SS&C. He interceded with the principal about SS&C and made sure the teachers' schedules provided sufficient time to deal with the new curriculum. He also made sure there were sufficient supplies.

Support Provided by the School

The school was very well equipped in terms of laboratory rooms, science materials and computers. Science classes were always held in laboratory-equipped rooms. The science department also had a laboratory assistant who gathered or made any necessary supplies and helped set up science activities. The teachers all had their own desks in a teacher room and often additional office type space in laboratory storage rooms between science classrooms. The school was supportive of standards-based instruction and of high achievement for all students. To accomplish this the school had strict attendance policies with personalized follow-up. There was a lot of teacher-parent interaction about individual students. All teachers were encouraged to engage in professional development. New teachers were carefully observed and mentored until they received tenure.

External Pressures

The Board of Regents controlled curriculum in the State of New York. At the beginning of the project the students in the SS&C classes only had to pass a general exam. By the time the project ended all students in the State were required to take at least one Regents' science class. The changing external requirements meant that the SS&C class as initially configured would not meet State graduation requirements.

Progress of the Implementation

The project began with the entire 9th grade, non-Regents students, in a "Topics" science class. Topics was mostly an earth science class with general science topics reviewed at the end of the course to help the students prepare for the general exam. One teacher taught all of the Topics sections. A team of four teachers taught the first year of SS&C. Students spent two weeks with one teacher then two weeks with another and so on throughout the year. The second year of SS&C the students again had SS&C taught by a team of teachers, but this time they spent one month with each teacher. The third year students switched teachers once a quarter. The fourth year SS&C was not really taught; students took Active Physics or Chemistry and Community for the entire year. The fourth and fifth years of SS&C students took Active Physics. The implementation effort appeared to have the most effect on the newer teachers. The enhancement training solidified and operationalized the pre-service training the teachers had received. Additionally the NRC Standards-based philosophy of SS&C matched with the philosophy of the science department so the teachers were mentored into a compatible philosophy.

Based on the teachers' reports of what topics were covered each year, the first year of SS&C showed a decrease in the amount of time teaching earth science and an increase in the time spent on physics, chemistry, and biology. After the first year the time spent teaching the four areas was more even for two years. Then the time spent changed to reflect the "pure" chemistry and physics courses that were taught instead of SS&C. (See Table 105 in the Appendix.)

New York High School Learning Environment Measures

The learning environment was assessed in four different ways. The students and teachers completed a questionnaire that asked about what activities occurred in the class. These activities were grouped into factors. On the student questionnaire there were four factors: inquiry, group work, traditional, and other. On the teacher questionnaire there were two factors: inquiry and traditional. The introduction to the individual site sections describes these factors and their analyses in detail. The third measure was observations of the classes by external observers. These observations allowed the class activities to be categorized into student-centered, teacher-centered, group, administrative and other. The fourth measure was a learning environment inventory with several scales related to the classroom psychosocial environment, which was completed by the students.

When forced into percent of total class time categories, the student questionnaire data showed a significant increase in the percent of time spent in group work and a corresponding significant decrease in inquiry the first year of SS&C, whichcontinued through all years of the study. The ratings of the scales showed that the students began by rating inquiry at several times per week and decreased to between several times and once a week. Group work began at slightly less than once a week and moved up to several times a week.

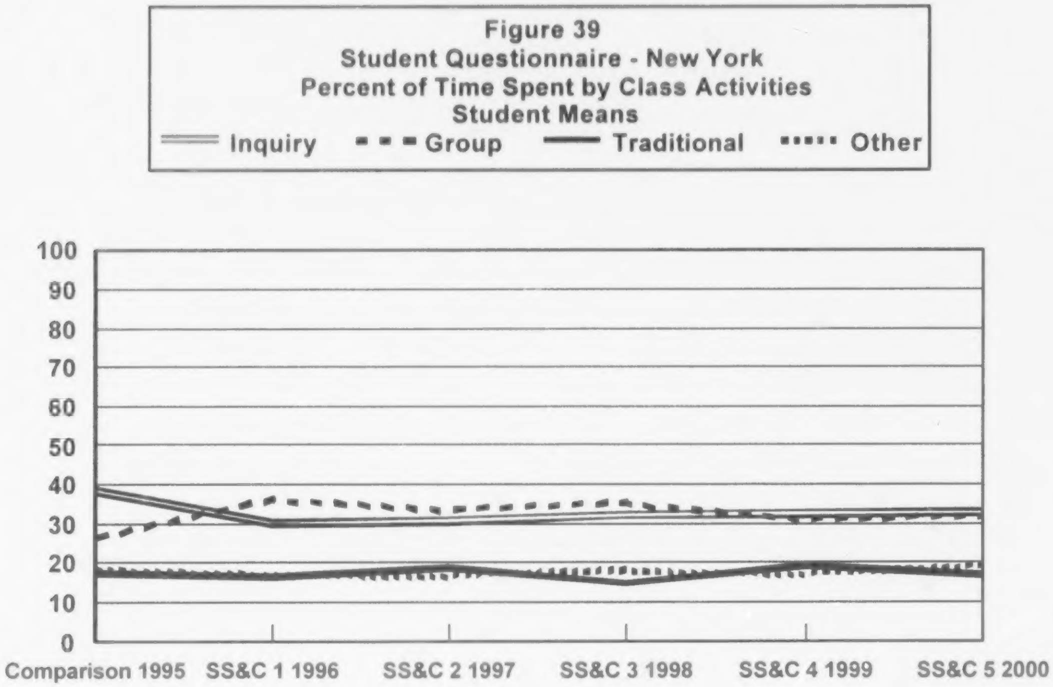


Figure 39
Student Questionnaire - New York
Percent of Time Spent by Class Activities
Student Means

The teacher questionnaire data were not forced into percentages like the student data. Only the frequencies are presented below. There were no significant changes. The scores ranged from a low of less than once a week for the traditional activities to a high of more than several times a week for the inquiry activities.

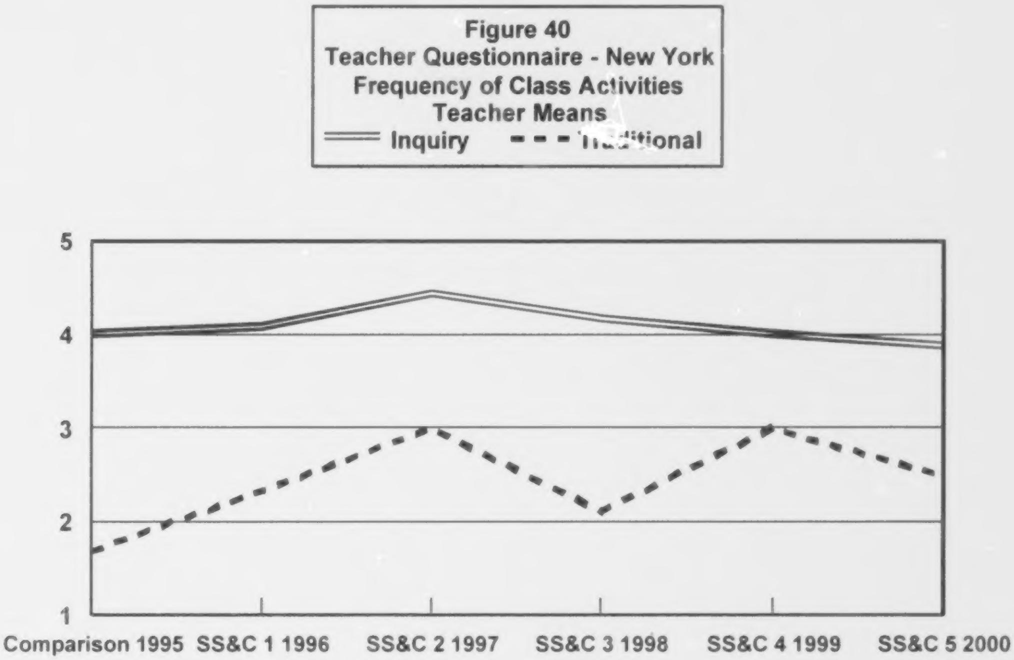
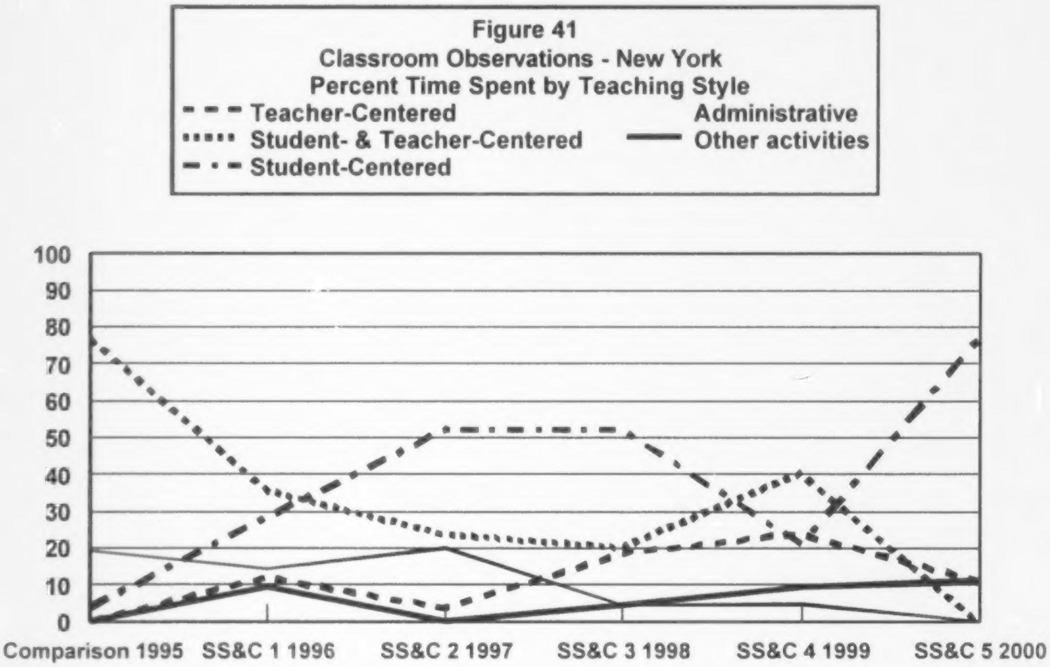


Figure 40
Teacher Questionnaire - New York
Frequency of Class Activities
Teacher Means

During the last three years of the project, questions were added to the teacher questionnaire. Teachers were also asked to rate the percent of time they spent in whole class activities, group activities, and individual activities. After doing these ratings, the teachers then described what happened within each category. These data showed that whole class activity increased and that it was mostly due to increases in demonstrations. The teachers also reported that time in individual activities decreased, and the mix of individual activities changed to include more journaling, computer work, and worksheets. (See Tables 112-114 in the Appendix.)

The classroom observation data showed a significant change toward a more student-centered environment at the beginning of SS&C and then a decline and then a resurgence this past year. Student-centered behaviors changed from 10% of the time to about 50% of the time and then up to 75% percent of the time after a brief decline to 20% in 1999. These changes were mirrored by opposite changes in student- and teacher-centered behavior.

Figure 41
Classroom Observations - New York
Percent Time Spent by Teaching Style



As a second look at the classrooms, the observation forms asked the observer to rate the level of student involvement and type of instruction. These ratings showed no significant changes except for student involvement in 2000 and type of instruction in 1999, but showed a trend toward less student involvement and more inquiry-oriented instruction.

The scales on the learning environment inventory were mostly stable except for a significant increase in sequencing the first two years of SS&C and then a slight decrease back to original levels until the last year when sequencing increased significantly again and difficulty decreased significantly.

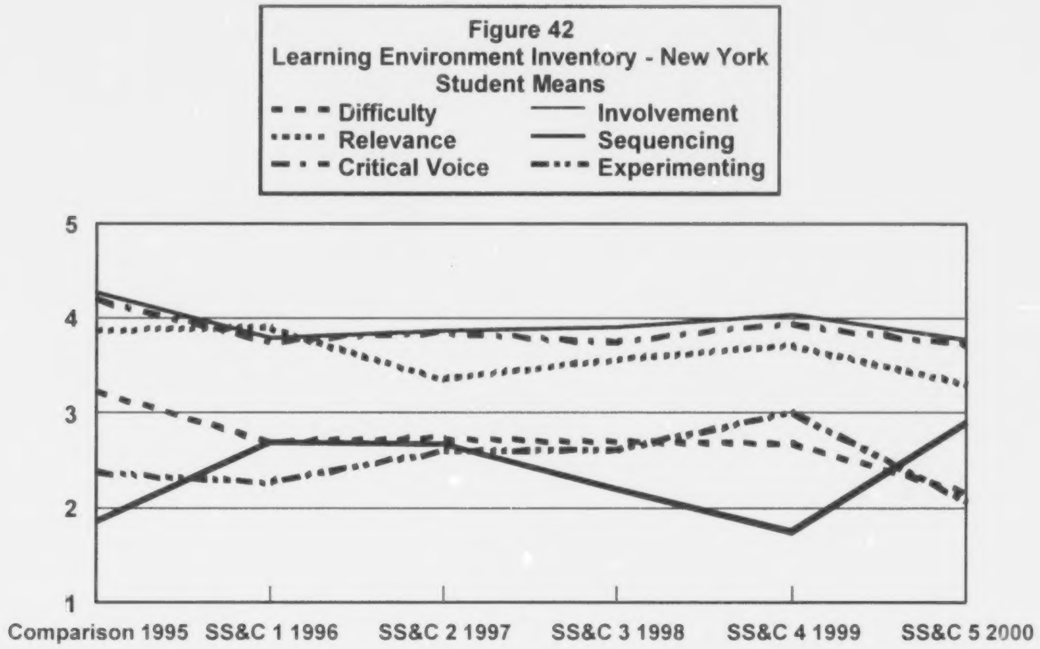


Figure 42
Learning Environment Inventory - New York
Student Means

The changes seemed to be directly related to the SS&C enhancement effort in the first two years, and then environments became highly dependent on the individual teachers involved in the Topics classes. At least part of the increase in student-centered activities the last years was due to the nature of the students in the classes. Over the years the proportion of special education students in the classes increased, and along with this came the need for individualized instruction. Additionally the curriculum used in the last years was designed to be student-centered.

New York High School Student Outcome Measures

The student outcome information is grouped in two ways. The inclination of students to continue studying science and student motivation and attitude toward science is one group, and student achievement on the science literacy multiple choice items, science literacy open-ended items, lab skills performance test, and written full investigations is the second. There were only a small number of students involved in the classes at New York High School. Therefore differences must be quite large to be statistically significant and averages are much more subject to influence by individual scores.

Attitude & Motivation Measures

There were few changes in student inclination to study science, no doubt because of the strict and continuous State requirements. There was a significant increase and then decrease in the students wanting to pursue a career in science in 1999 and significant decreases in 1998 and 2000 in students believing science activities made them want to take more science. This may be due to the increasing proportion of special education students in the course. In 1998, there was a significant drop in "finding science class motivating" and "science class is interesting," but these returned to comparison year levels.

Figure 43
Student Questionnaire - New York
Inclination to Continue Studying Science
Percentage of Students who Responded "YES"

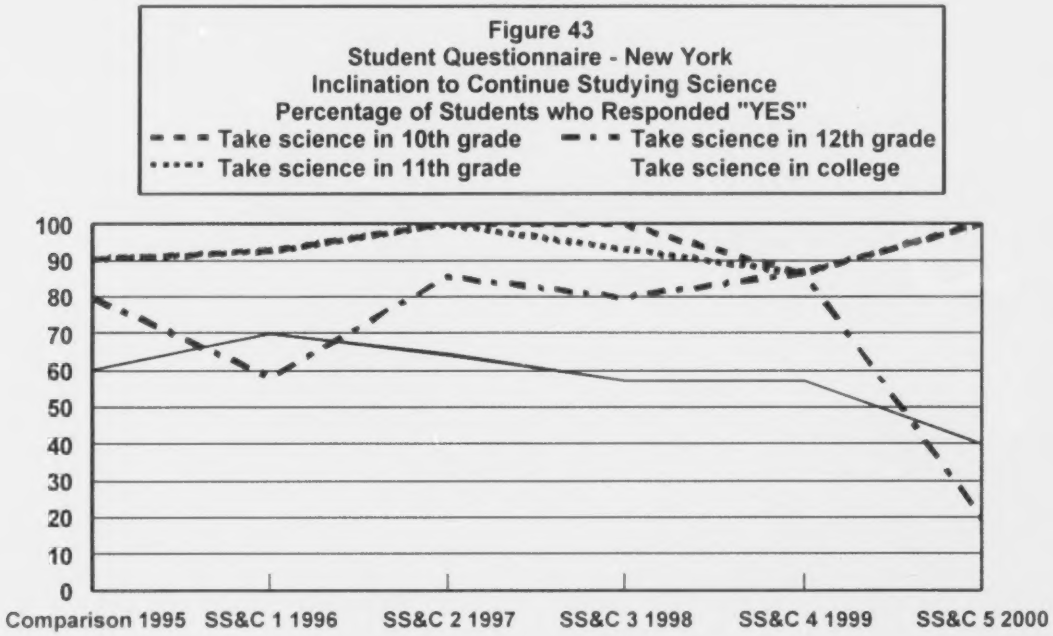


Figure 44
Student Questionnaire - New York
Science Motivation
Percentage of Students who Responded "YES"

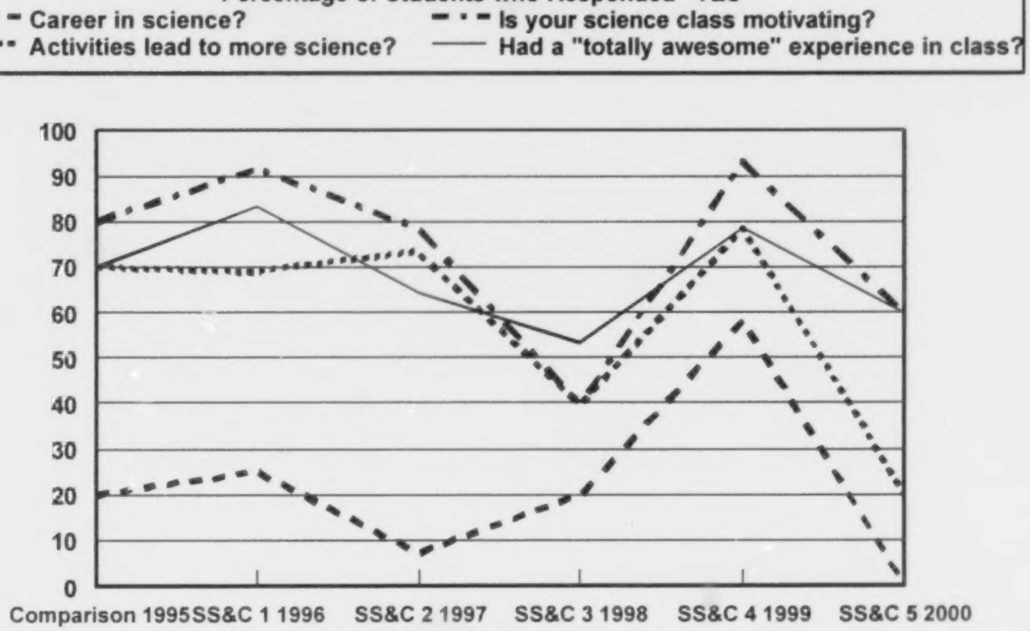
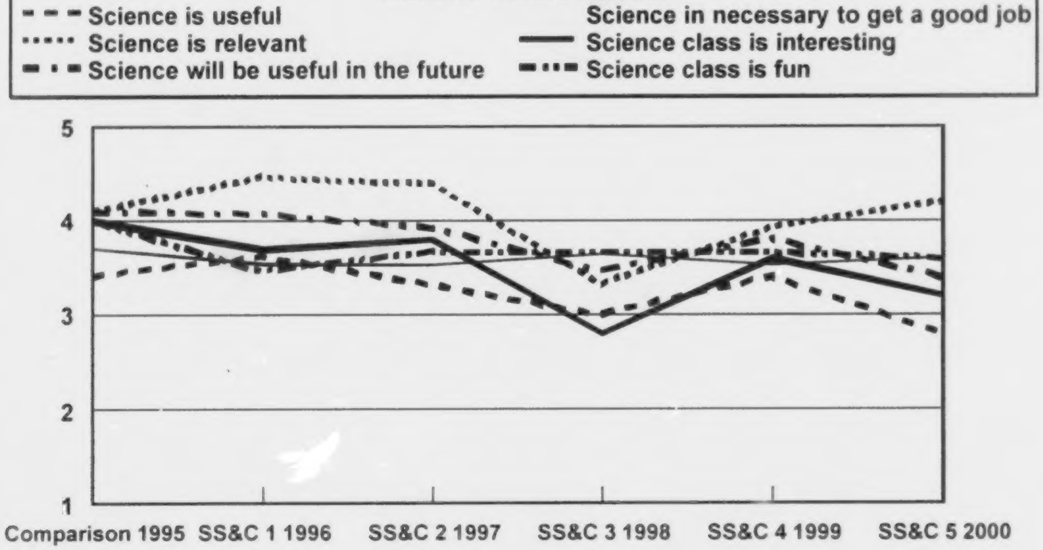


Figure 45
Student Questionnaire - New York
Attitudes Toward Science



Achievement Measures

There were some changes in student achievement in keeping with the changes in classroom environment. The lab skills performance test, the written full investigation and the science literacy open-ended items showed significant increases the first two years of SS&C. These differences continued into 1998 for the science literacy open-ended items and the lab skills performance test. The lab skills performance test, the science literacy open-ended items, and the hands-on full investigation showed significant differences from the comparison year in 2000. The differences for the first three years on the lab skills performance test were due mostly to differences on the rock identification and instruments tasks. These differences seemed most related to the increased and continuous use of student laboratory activities in the classes in contrast to the comparison year. Even though SS&C was not used, the Active Physics that replaced it is also a very hands-on curriculum. The effect size chart revealed positive educationally significant changes for the labs skills performance test and science literacy open-ended questions in all but one year. There were also positive educationally significant changes for the hands-on full investigation (1997, 1999 and 2000) and the written full investigation (1996-1998). Negative educationally notable changes occurred for the written full investigation in 1999.

Figure 46
Achievement Scores - New York
Student Means
Percent Correct on Achievement Tests

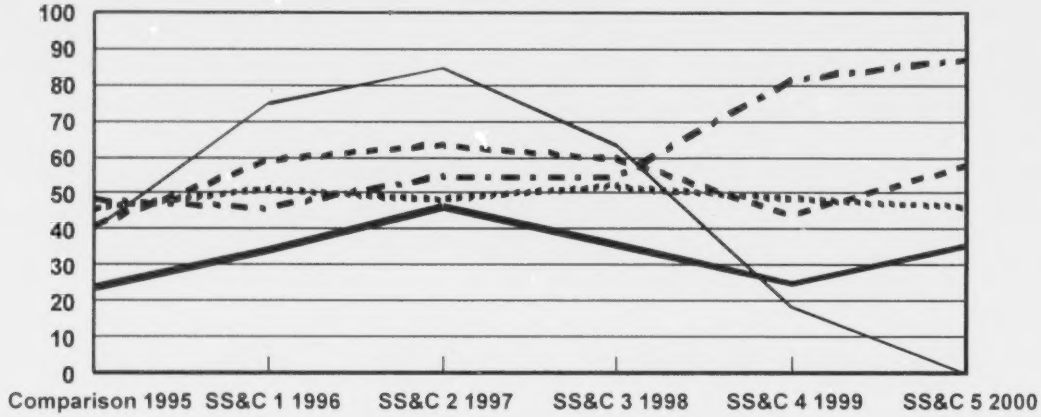
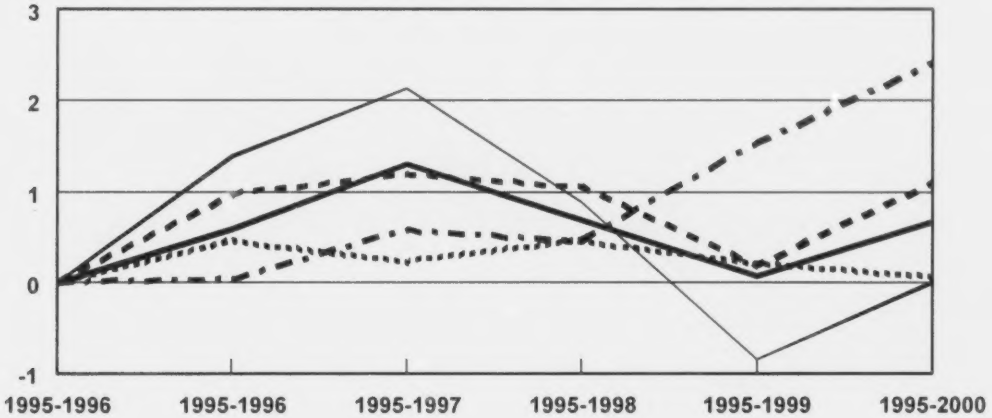


Figure 47
New York
Achievement Effect Sizes



Summary of New York High School

In summary the New York High School implementation was incomplete. Considering their experience in light of the proposed model for teacher enhancement highlights several crucial components. Initially the school was not wholly ready to participate in the implementation. The school was well equipped to implement the curriculum. The principal and the department head were very supportive; the teachers were well qualified and believed in inquiry-based science instruction; the school had all of the physical resources necessary for the curriculum, and in general the community and students were interested in trying something new. On the other hand, although some teachers were interested in the effort, others had mixed feelings or were actively opposed to the curriculum. Many believed what they were doing already was better than anything the new curriculum would be able to provide.

The first enacted curriculum reflected the skill and perceptions of the teachers at the school. They rearranged the curriculum to better take advantage of their instructional skills and content expertise and implemented it in that format using teams of teachers. The classes were very student-centered and hands-on, and student attitude and achievement went up slightly. Not all teachers' perceptions about the curriculum, however, were positive. At times attitudes toward the curriculum were based more on attitudes toward the liaison teacher who was supportive of the program than the curriculum itself. Because of these mixed impressions and the new sets of teachers involved each year, the curriculum was continuously modified. Classrooms stayed more student-centered, and lab skills stayed higher for a few years. No teachers had the course as a continuous responsibility, and it was difficult to coordinate the efforts of the team of teachers. Eventually the course devolved into being taught by one teacher. In addition to the continuous changes due to the different teachers, the State and the school changed their support of the course. At first the course was an acceptable one for graduation; however, during the course of the study the rules changed and the course was no longer acceptable. Therefore the value of the course was significantly decreased. The prestige was further diminished through the administration's rescheduling of the students who could take the course so that the mix of students became proportionately more special education students. By the fourth year of the study nothing of the original project was left except in the attitudes of some of the newer teachers who had participated in the training. Completely different curriculums, although also Standards-based, were being used in the classes.

X. TEXAS HIGH SCHOOL

Detailed information about this site is contained in prior reports. What will be presented here is a description of the implementation effort at the site in terms of the nature of the community, school, and the students, the teachers involved in the implementation, the liaison person, the emotional and material support provided by the school, external pressures and the progress of the implementation effort.

Nature of the Community, School and Students

During the study, Texas High School was near the downtown of a large city and only blocks away from two Universities. The surrounding urban area was small tract housing or larger three story walk-ups. The residential area was somewhat mixed with larger single family homes further away from the school. The community ranged economically from very low to middle class. The student population was almost entirely African American with a few Asian American and Hispanic/Latino American students. The community and the population of the school were stable over the course of the study.

The school was housed in an older traditional style three-story brick/cement block building in a "U" shape. The building was generally clean but minimalist and stark in appearance. The parking lot was fenced in, and the classrooms were kept locked. Staff were assigned to watch the halls, but the spirit was more one of concerned parents keeping track of their children than policing. The science classrooms were grouped together in one hall. Most science teachers had two classrooms in the hall, a traditional classroom with moveable desks and a science laboratory room. Ninth grade science class sizes over the years ranged from 15-34. Classes were offered on a 90-minute block schedule with different classes on alternating "A" and "B" days.

Nature of the Teachers

There were approximately 11 science teachers in the school each of the data collection years. The teachers usually taught in their areas of specialty, so of the 11 science teachers, three to seven taught from two to six sections of 9th grade science each. There were only two teachers who taught 9th grade science every year. Other slots saw a lot of turnover. There were several teachers involved in the different training opportunities. Each year, however, several new teachers were responsible for teaching SS&C. There were two teachers who attended the training who were involved in teaching SS&C for the entire period of the study. The two long-term teachers had been at the school for many years before SS&C began. They were both mainly physical science teachers and personally interested in their students' success. One was also particularly interested in hands-on activities. The new teachers were necessary because of changing external requirements and because of teacher turnover. Hope for, and belief in, the students was high among the teachers. Some of the science teachers were former Texas High School graduates who came back to share their success and understanding with the students. The students were generally polite and were well behaved when kept occupied. There was an acceptance of school, and the attendance rate was 92%.

Nature of the Liaison

The liaison for this site was the science department chairperson for the first two years of the project. The third year she resigned from her position as chairperson, and then she retired. One of the long-term teachers then became liaison teacher. The first liaison teacher was very supportive of SS&C and made sure the teachers' schedules provided sufficient time to deal with the new curriculum and that the district provided the necessary supplies. She was available for questions and actively lobbied the principal to support the SS&C implementation. The third year she still was supportive of SS&C and tried to help the newer teachers in their implementation, but she was no longer in a position of direct power. The fourth year the new liaison teacher was also the 9th grade curriculum coordinator.

Support Provided by the School

Based on interviews, the principal appeared to be astute politically and concerned about enhancing the reputation of the school. The district was quite large and the principal felt that he was responsible for implementing many of the District's and the State's constraints on instruction and curriculum. Over the years the principal's interest in SS&C changed. He was quite supportive in the first years when the project was funded and had a national focus, but that dwindled to what appeared to be a neutral, apathetic attitude when the funding was cut. There were few supplies at the school, but what could be provided was available to the teachers. The district was neutral in terms of the SS&C curriculum. Although the 9th grade teachers were part of the entire science department, they were a fairly distinct and separate group.

External Pressures

Although individual school districts in Texas had some choice in the curricula they used, the State provided an approved list. At the beginning of the project there was no required 9th grade curriculum. By the time the project ended all students in the State were required to take physical science in 9th grade. The changing external requirements meant that the SS&C class as initially configured would not meet State graduation requirements. It also meant that teachers with a biology certification could not teach the class even if it retained some biological components of SS&C.

Progress of the Implementation

The project began with the 9th grade students taking a variety of science classes although most were in some sort of physical science. When SS&C began all 9th grade students were enrolled. This continued for three years. After the third year of the implementation the State required 9th grade to be physical science. The district took the State guidelines and developed its own 9th grade science course that all students were then required to take. The second 9th grade liaison teacher was part of the district team developing the new 9th grade physical science course.

Based on the teacher's reports of what topics were covered each year, the first year of SS&C showed an increase in the time spent teaching biology and earth science and a decrease in the time spent teaching chemistry and physics. After that first year, the amount of time spent teaching the four science areas stayed fairly even until 1999 when the classes became only physical science (physics and chemistry) once again. (See Table 131 in the Appendix.)

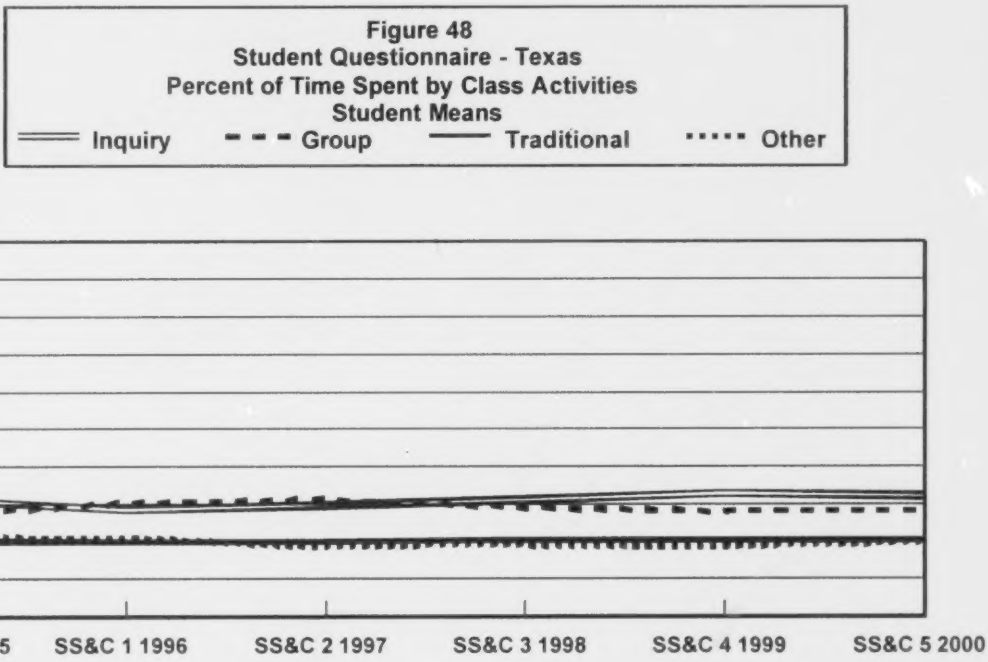
Texas High School Learning Environment Measures

The learning environment was assessed in four different ways. The students and teachers completed a questionnaire that asked about what activities occurred in the class. These activities were grouped into factors. On the student questionnaire there were four factors: inquiry, group work, traditional, and other. On the teacher questionnaire there were two factors:

inquiry and traditional. The introduction to the individual site sections describes these factors and their analyses in detail. The third measure was observations of the classes by external observers. These observations allowed the class activities to be categorized into student-centered, teacher-centered, group, administrative and other. The fourth measure was a learning environment inventory with several scales related to the classroom psychosocial environment, which was completed by the students.

When forced into percent of total class time categories, the student scales showed that there were significant increases in the percent of class time spent on group work and decreases in the percent of time spent on other and inquiry activities, which continued for the first three years of the enhancement effort. The group work began at slightly less than once a week and moved up to between once a week and several times a week. Despite the decrease in the percent of class time spent on inquiry, inquiry activity increased from about once a week to slightly higher than that.

Figure 48
Student Questionnaire - Texas
Percent of Time Spent by Class Activities
Student Means



The teacher questionnaire data were not forced into percentages like the student data. Only the frequencies are presented below. There were no significant changes. The scores ranged from a low of slightly less than once a week for the traditional activities, to a high of more than several times a week for the inquiry activities.

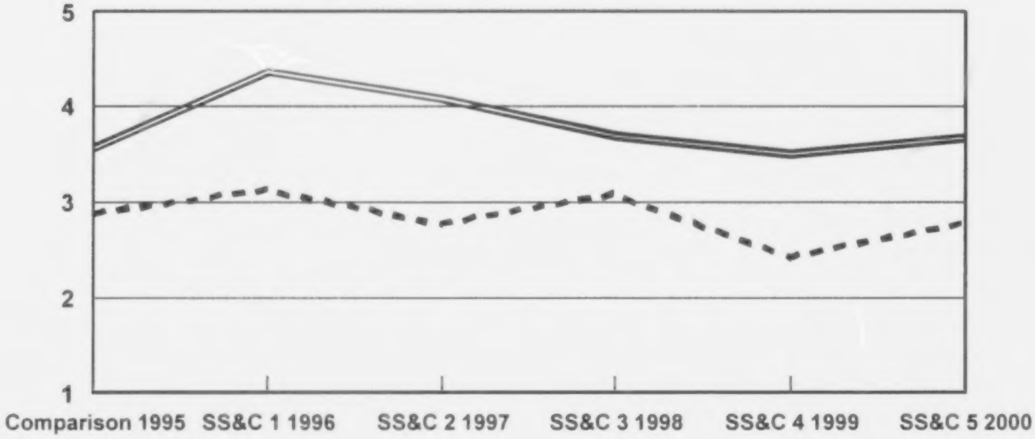


Figure 49
Teacher Questionnaire - Texas
Frequency of Class Activities
Teacher Means

During the last three years of the project, new questions were added to the teacher questionnaire. Teachers were also asked to rate the percent of time they spent in whole class activities, group activities, and individual activities. After doing these ratings, the teachers then described what happened within each category. Based on these ratings, the amount of whole class activities decreased, and individual activities increased. The mix of individual activities reported showed a decrease in lab write-ups and an increase in text reading and other activities. (See Tables 138-140 in the Appendix.)

The classroom observations showed a significant decrease in teacher-centered behavior with significant increases in student-centered behavior for the first two years of SS&C and then significant increases in teacher-centered behavior again. Student-centered behavior ranged from a low of about 10% to a high of 40% and back down to about 10%. Student- and teacher-centered behavior increased from 10% to 40% in 1997 and remained there.

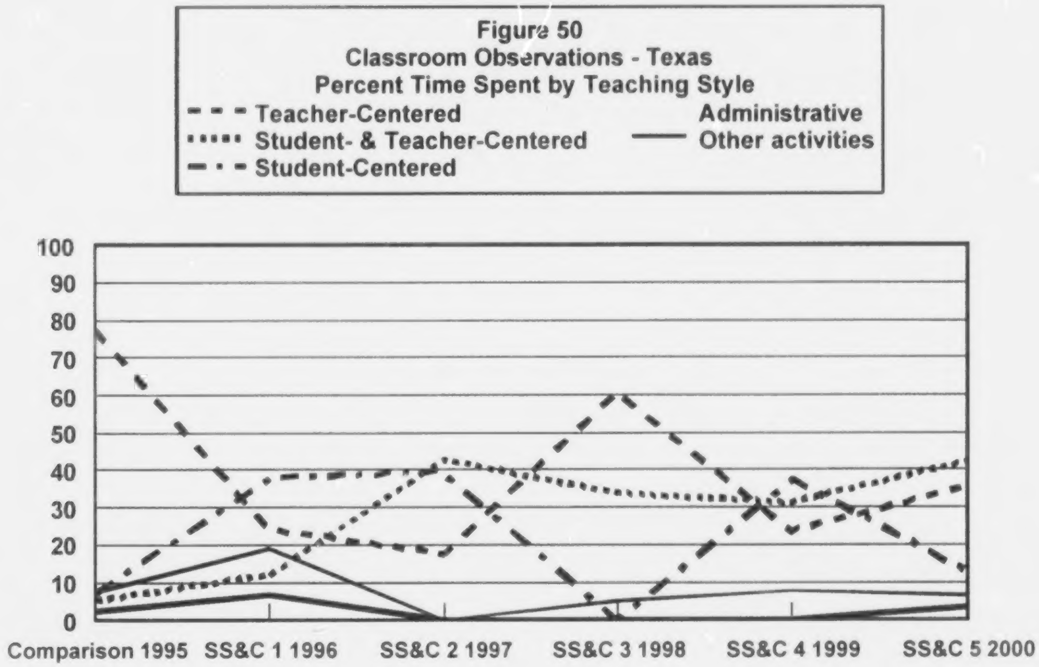


Figure 50
Classroom Observations - Texas
Percent Time Spent by Teaching Style

As a second look at the classrooms, the observation forms asked the observer to rate the level of student involvement and the type of instruction. These ratings showed no significant changes but showed a trend toward less student involvement in later years.

The learning environment scales showed continuous significant increases in relevance and involvement and significant increases in experimenting for the first three years. The other scales showed mixed results or stability.

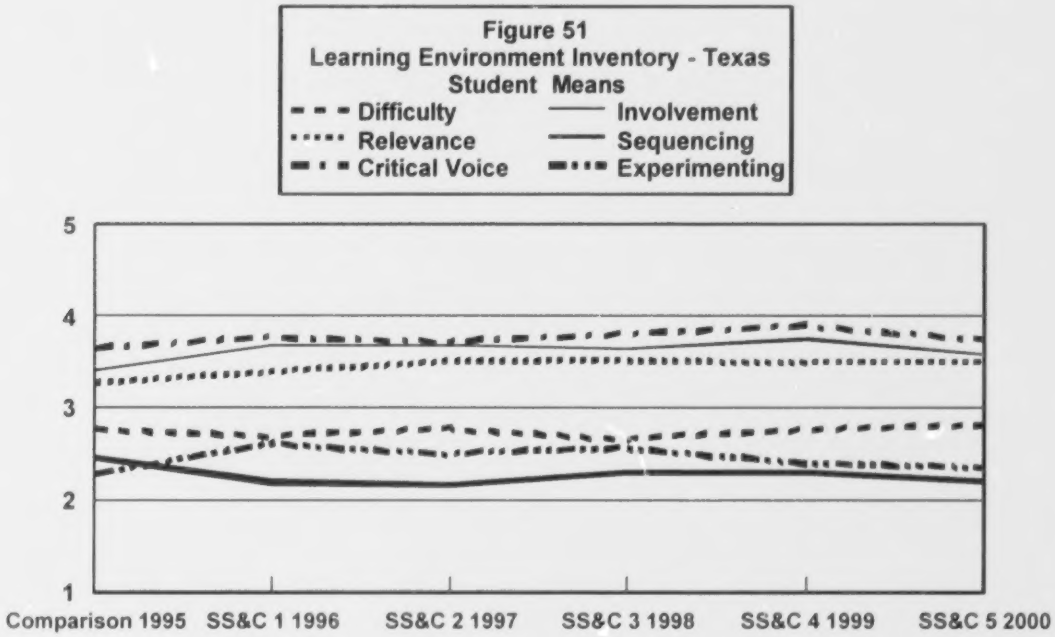


Figure 51
Learning Environment Inventory - Texas
Student Means

The changes in the learning environment seemed directly related to the SS&C enhancement. Despite new teachers, they tried to consistently use the curriculum in the intended ways for the first few years. After those years the implementation was very teacher specific with most teachers doing what they felt was best. With the implementation of the new physical science class the individualization increased even more. Within the individual styles fewer teachers chose to use hands-on activities.

Texas High School Student Outcomes Measures

The student outcome information is grouped in two ways. The inclination of students to continue studying science and student motivation and attitude toward science is one group and student achievement on the science literacy multiple choice items, science literacy open-ended items, lab skills performance test, and written full investigations is the second.

Attitude & Motivation Measures

The initial increases in student-centeredness and the use of more hands-on activities in the classes appeared to contribute to some changes in student attitudes. There were significant and sustained differences in students finding their science class motivating, and students reported significantly more "totally awesome" experiences for the first three years. There were also significant increases the first year in students wanting to pursue a career in science and in the first two years in wanting to take more science. Students found their science classes significantly more interesting than the comparison year for the first three years and significantly more fun for the first four years.

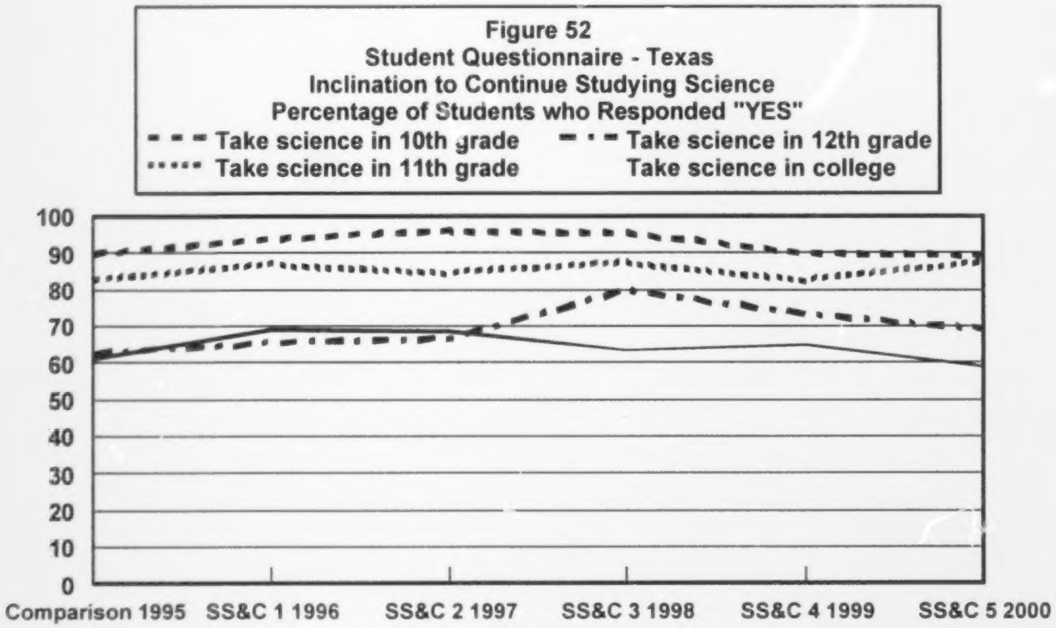


Figure 52
Student Questionnaire - Texas
Inclination to Continue Studying Science
Percentage of Students who Responded "YES"

Figure 53
Student Questionnaire - Texas
Science Motivation
Percentage of Students who Responded "YES"

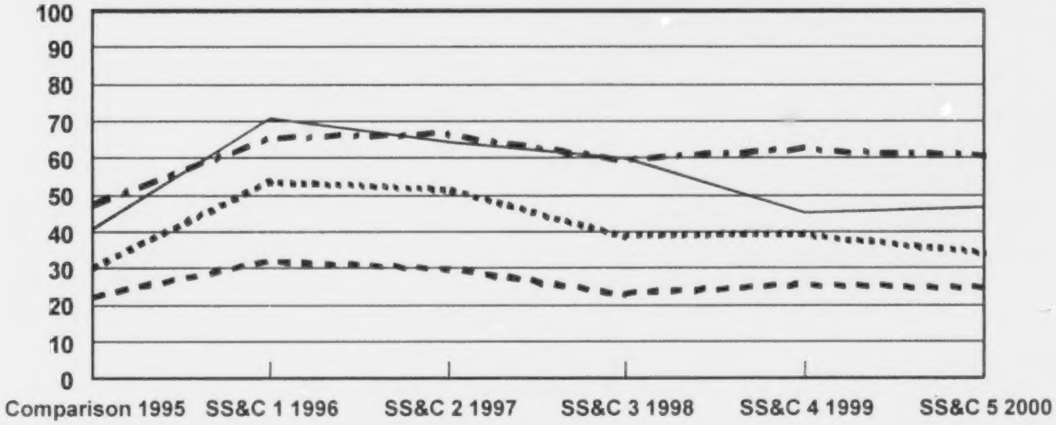
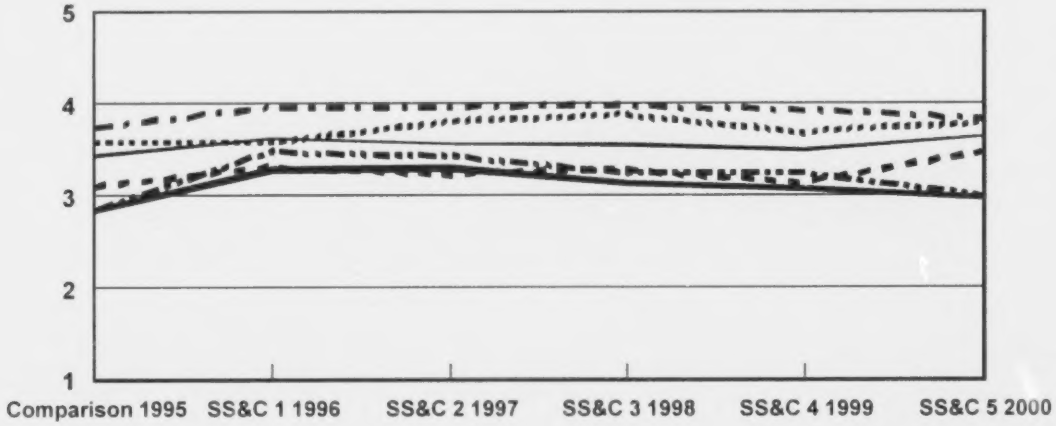


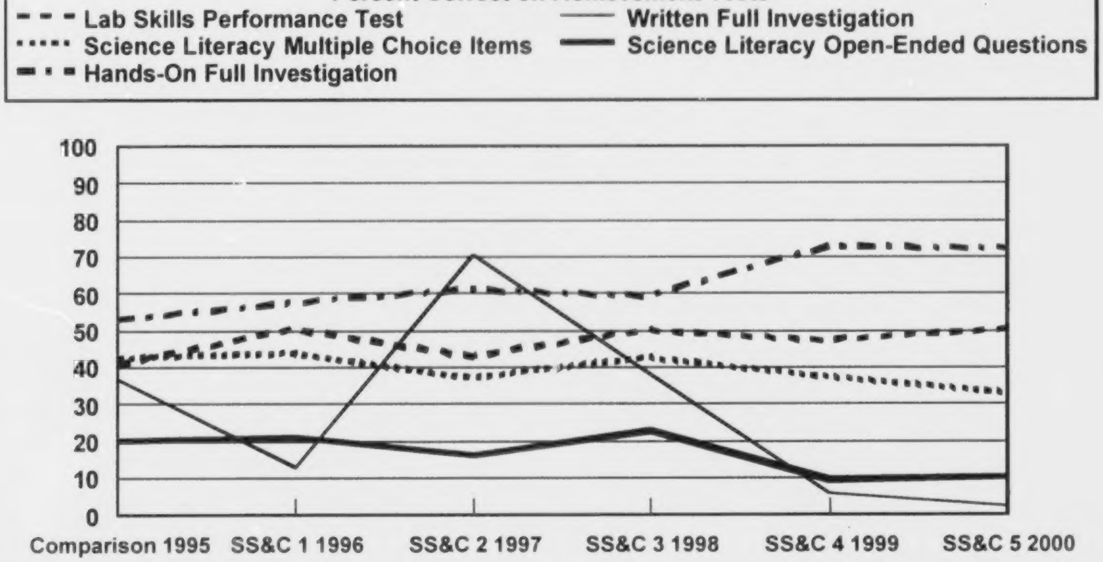
Figure 54
Student Questionnaire - Texas
Attitudes Toward Science



Achievement Measures

Despite the changes in student attitude, there were few effects on student achievement. The SS&C students had significantly higher scores than the comparison year students on the lab skills performance test the first and third years of the implementation. These effects were mostly due to scores on the rock identification station. The effects in the second, fourth and fifth years on the literacy test and the fourth and fifth years on the science literacy open-ended items showed significant decreases in contrast to the comparison year levels. The decreases on the literacy test showed up for almost all of the scales. The effect size chart revealed positive educationally significant changes for the lab skills performance test (1996, 1998 and 2000), the hands-on full investigation (1999, 2000), and the written full investigation (1997). Negative educationally significant changes occurred for the written full investigation (1996, 1999 and 2000), the science literacy open-ended questions (1999 and 2000), and the science literacy multiple choice items (2000).

Figure 55
Achievement Scores - Texas
Student Means
Percent Correct on Achievement Tests



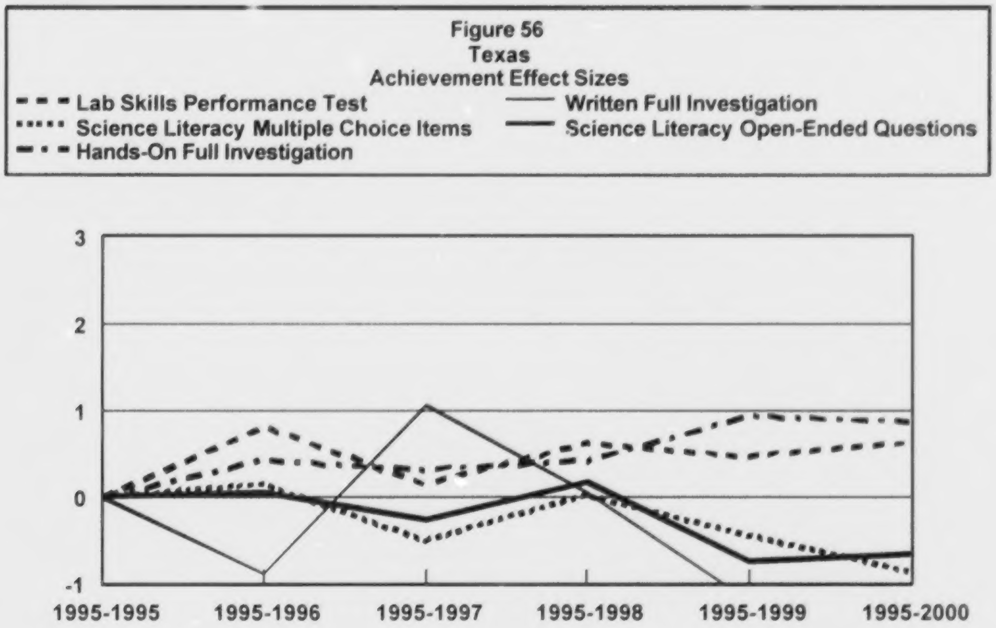


Figure 56
Texas
Achievement Effect Sizes

Summary of Texas High School

In summary the Texas High School implementation was incomplete. Considering their experience in light of the proposed model for teacher enhancement highlights several crucial components. The school was not wholly prepared to implement the curriculum. The faculty, and especially the liaison teacher, were committed to it and felt it would really help their students. The principal and the school district were supportive. There was not appropriate equipment to support the implementation, and not all the teachers were qualified to teach it. The first enacted curriculum directly matched the intended curriculum in terms of activities to be covered. The teachers were hampered, however, by the lack of equipment and materials. There was additional teacher training provided by a nearby University. The classes were more student-centered and hands-on. The second year of the implementation new teachers were hired to teach the curriculum. They had some training but not as much as the prior group. Only two teachers from the prior group remained. The curriculum was still implemented as planned. The liaison teacher was quite active in supporting the new teachers, and the administration was very supportive. The third year there were once again new teachers teaching the curriculum and even fewer resources since the funding for the implementation project had ceased. The liaison teacher was no longer department chair and was less influential in supporting the curriculum.

This year the curriculum was implemented in a more individualized fashion with each teacher doing what he or she felt best and with overall increases in traditional instructional styles. This trend continued until the end of the evaluation project. In the last years the State required that the 9th grade class be physical science rather than the coordinated science of the implementation project. In addition the State instituted a high stakes test, and much of the science class time was spent in directly preparing students for the material on that exam. These requirements meant that most of the curriculum was abandoned except for some physical science activities and some changes in the minds of the two remaining instructors.

Appendix

Evaluating the Long Term Effects of Teacher Enhancement

February, 2001

Frances Lawrenz
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Appendix A
Tables of Results

Introduction

The following tables include the means, standard errors and test statistics for each of the analyses conducted as part of the evaluation of SS&C. All analyses used a two-tailed test with statistical significance defined as $p \leq .05$. Although statistical significance is not necessarily equated with practical significance, test statistics were used to help interpret differences between groups. Student means were used to analyze student data. Although the treatment (SS&C in this case) was administered by class, there were insufficient numbers of classes to justify using the class as the unit of analysis. Thus, even though using student means provides a less rigorous comparison and leads to a greater likelihood of finding statistically significant differences, it was determined that using the student as the unit of analysis was the only justifiable course.

Table 1
Student Questionnaire
Student Means
Percent Time Spent on Inquiry Class Activities

School	Comparison (1995)			SS&C 1 (1996)			SS&C 2 (1997)			SS&C 3 (1998)			SS&C 4 (1999)			SS&C 5 (2000)		
	mean	s.e.	n	mean	s.e.	n	mean	s.e.	n	mean	s.e.	n	mean	s.e.	n	mean	s.e.	n
California	29.70	0.39	274	28.21	0.31	315	27.89	0.34	293	28.91	0.34	351	29.79	0.44	233	30.57	0.49	186
Iowa	35.82	0.67	105	30.35	0.48	151	31.59	0.43	140	30.54	0.33	147	32.12	0.45	155	31.97	0.40	131
Montana	28.99	0.34	228	31.19	0.46	88	31.20	0.53	82	32.89	0.49	137	32.57	0.40	123	33.03	0.36	147
New York	38.37	1.96	11	30.04	1.48	12	30.69	0.97	13	32.19	1.95	13	32.53	1.85	11	32.78	2.11	3
Texas	31.26	0.56	201	28.50	0.49	192	29.62	0.55	191	31.10	0.61	157	32.77	0.77	133	32.02	0.84	90

Statistical Tests

School	1995 vs. 1996			1995 vs. 1997			1995 vs. 1998			1995 vs. 1999			1995 vs. 2000		
	Δ	t	p	Δ	t	p	Δ	t	p	Δ	t	p	Δ	t	p
California	-1.49	-2.97	<.01	-1.81	-3.50	<.01	-0.79	-1.53	.13	0.08	0.14	.89	0.87	1.39	.16
Iowa	-5.47	-6.63	<.01	-4.23	-5.32	<.01	-5.28	-7.06	<.01	-3.70	-4.56	<.01	-3.85	-4.93	<.01
Montana	2.20	3.85	<.01	2.21	3.49	<.01	3.90	6.56	<.01	3.58	6.77	<.01	4.04	8.14	<.01
New York	-8.34	-3.39	<.01	-7.68	-3.51	<.01	-6.18	-2.23	.03	-5.85	-2.16	.03	-5.59	-1.94	.05
Texas	-2.76	-3.69	<.01	-1.65	-2.09	.04	-0.17	-0.20	.84	1.51	1.58	.11	0.76	0.75	.45

Table 2
Student Questionnaire
Student Means
Percent Time Spent on Group Class Activities

School	Comparison (1995)			SS&C 1 (1996)			SS&C 2 (1997)			SS&C 3 (1998)			SS&C 4 (1999)			SS&C 5 (2000)		
	mean	s.e.	n	mean	s.e.	n	mean	s.e.	n	mean	s.e.	n	mean	s.e.	n	mean	s.e.	n
California	29.94	0.34	274	33.32	0.32	315	34.70	0.35	293	35.18	0.37	351	35.15	0.43	233	33.66	0.50	186
Iowa	25.49	0.43	105	37.14	0.38	151	35.15	0.35	140	34.13	0.33	147	34.88	0.37	155	33.90	0.42	131
Montana	27.36	0.28	228	34.46	0.46	88	33.80	0.59	82	34.20	0.43	137	34.11	0.36	123	34.28	0.31	147
New York	26.12	1.93	11	36.20	1.08	12	33.65	0.82	13	34.97	2.91	13	31.07	1.19	11	31.44	1.21	3
Texas	27.12	0.52	201	30.12	0.51	192	31.34	0.57	191	29.41	0.59	157	28.04	0.75	133	28.07	0.88	90

Statistical Tests

School	1995 vs. 1996			1995 vs. 1997			1995 vs. 1998			1995 vs. 1999			1995 vs. 2000		
	Δ	t	p	Δ	t	p	Δ	t	p	Δ	t	p	Δ	t	p
California	3.39	7.28	<.01	4.77	9.80	<.01	5.24	10.47	<.01	5.21	9.46	<.01	3.72	6.17	<.01
Iowa	11.65	20.15	<.01	9.67	17.32	<.01	8.65	15.93	<.01	9.39	16.39	<.01	8.42	13.89	<.01
Montana	7.10	13.23	<.01	6.44	9.79	<.01	6.84	13.26	<.01	6.75	14.87	<.01	6.92	16.47	<.01
New York	10.09	4.56	<.01	7.53	3.60	<.01	8.86	2.54	.01	4.95	2.18	.03	5.33	2.34	.02
Texas	3.00	4.13	<.01	4.22	5.48	<.01	2.28	2.91	<.01	0.92	1.01	.31	0.95	0.93	.35

Table 3
Student Questionnaire
Student Means
Percent Time Spent on Traditional Class Activities

School	Comparison (1995)			SS&C 1 (1996)			SS&C 2 (1997)			SS&C 3 (1998)			SS&C 4 (1999)			SS&C 5 (2000)		
	mean	s.e.	n	mean	s.e.	n	mean	s.e.	n	mean	s.e.	n	mean	s.e.	n	mean	s.e.	n
California	18.00	0.34	274	18.64	0.28	315	16.96	0.31	293	17.48	0.28	351	17.58	0.38	233	17.34	0.36	186
Iowa	16.84	0.42	105	16.46	0.37	151	16.07	0.38	140	17.45	0.34	147	16.67	0.30	155	16.90	0.34	131
Montana	22.19	0.33	228	16.92	0.56	88	17.56	0.44	82	16.65	0.42	137	17.66	0.41	123	17.07	0.37	147
New York	17.31	1.77	11	16.51	0.90	12	18.78	1.50	13	14.90	1.42	13	19.24	1.85	11	16.87	1.56	3
Texas	20.24	0.42	201	20.05	0.45	192	20.13	0.43	191	20.45	0.46	157	20.51	0.60	133	20.46	0.66	90

Statistical Tests

School	1995 vs. 1996			1995 vs. 1997			1995 vs. 1998			1995 vs. 1999			1995 vs. 2000		
	Δ	t	p	Δ	t	p	Δ	t	p	Δ	t	p	Δ	t	p
California	0.65	1.45	.15	-1.03	-2.23	.03	-0.51	-1.16	.25	-0.42	-0.82	.41	-0.65	-1.31	.19
Iowa	-0.38	-0.68	.50	-0.76	-1.36	.17	0.61	1.14	.25	-0.17	-0.34	.73	0.06	0.11	.91
Montana	-5.26	-8.17	<.01	-4.63	-8.44	<.01	-5.53	-10.46	<.01	-4.53	-8.69	<.01	-5.12	-10.43	<.01
New York	-0.80	-0.40	.69	1.47	0.63	.53	-2.41	-1.06	.29	1.93	0.75	.45	-0.44	-0.18	.86
Texas	-0.19	-0.30	.76	-0.10	-0.17	.87	0.22	0.35	.73	0.27	0.37	.71	-9.78	-12.51	<.01

Table 4
Student Questionnaire
Student Means
Percent Time Spent on Other Class Activities

School	Comparison (1995)			SS&C 1 (1996)			SS&C 2 (1997)			SS&C 3 (1998)			SS&C 4 (1999)			SS&C 5 (2000)		
	mean	s.e.	n	mean	s.e.	n	mean	s.e.	n	mean	s.e.	n	mean	s.e.	n	mean	s.e.	n
California	22.37	0.32	274	19.82	0.27	315	20.44	0.27	293	18.43	0.25	351	17.49	0.31	233	18.43	0.40	186
Iowa	21.85	0.34	105	16.05	0.34	151	17.19	0.26	140	17.88	0.27	147	16.33	0.27	155	17.23	0.34	131
Montana	21.47	0.26	228	17.43	0.39	88	17.45	0.48	82	16.26	0.27	137	15.66	0.29	123	15.62	0.26	147
New York	18.20	1.25	11	17.25	1.46	12	16.88	1.19	13	17.94	1.58	13	17.16	1.28	11	18.90	2.66	3
Texas	21.38	0.39	201	21.32	0.45	192	18.91	0.40	191	19.05	0.54	157	18.68	0.61	133	19.45	0.63	90

Statistical Tests

School	1995 vs. 1996			1995 vs. 1997			1995 vs. 1998			1995 vs. 1999			1995 vs. 2000		
	Δ	t	p	Δ	t	p	Δ	t	p	Δ	t	p	Δ	t	p
California	-2.54	-6.02	<.01	-1.92	-4.58	<.01	-3.93	-9.61	<.01	-4.88	-7.03	<.01	-3.94	-7.70	<.01
Iowa	-5.80	-12.09	<.01	-4.67	-10.79	<.01	-3.97	-9.07	<.01	-5.52	-12.73	<.01	-4.63	-9.53	<.01
Montana	-4.03	-8.54	<.01	-4.02	-7.36	<.01	-5.21	-13.88	<.01	-5.80	-14.78	<.01	-5.84	-15.80	<.01
New York	-0.95	-0.49	.62	-1.32	-0.76	.45	-0.26	-0.13	.90	-1.04	-0.58	.56	0.70	0.24	.81
Texas	-0.06	-0.10	.92	-2.47	-4.44	<.01	-2.34	-3.53	<.01	-2.70	-3.73	<.01	-1.93	-2.60	.01

Table 5
Student Questionnaire
Student Means
Frequency of Inquiry Class Activities

School	Comparison (1995)			SS&C 1 (1996)			SS&C 2 (1997)			SS&C 3 (1998)			SS&C 4 (1999)			SS&C 5 (2000)		
	mean	s.e.	n	mean	s.e.	n	mean	s.e.	n	mean	s.e.	n	mean	s.e.	n	mean	s.e.	n
California	3.17	0.06	281	3.58	0.05	330	3.49	0.05	306	3.42	0.05	381	3.46	0.06	246	3.29	0.07	191
Iowa	3.14	0.09	107	3.40	0.08	154	3.88	0.07	142	3.56	0.06	150	3.67	0.07	160	3.59	0.07	132
Montana	3.25	0.05	234	3.66	0.08	95	3.49	0.10	83	3.65	0.07	139	3.83	0.07	128	3.89	0.05	153
New York	3.77	0.32	11	3.60	0.29	12	3.73	0.17	14	3.45	0.25	15	3.77	0.29	13	3.13	0.30	4
Texas	2.94	0.07	210	3.32	0.07	210	3.43	0.08	198	3.22	0.09	157	3.08	0.10	142	3.24	0.13	98

1 = Never, 2 = Less than once a week, 3 = About once a week, 4 = Several times a week, 5 = Almost every day

Statistical Tests

School	1995 vs. 1996			1995 vs. 1997			1995 vs. 1998			1995 vs. 1999			1995 vs. 2000		
	Δ	t	p	Δ	t	p	Δ	t	p	Δ	t	p	Δ	t	p
California	0.42	5.46	<.01	0.32	4.12	<.01	0.25	3.13	<.01	0.29	3.37	<.01	0.13	1.37	.17
Iowa	0.26	2.25	.03	0.75	6.90	<.01	0.42	4.17	<.01	0.53	4.96	<.01	0.45	4.25	<.01
Montana	0.40	4.09	<.01	0.24	2.21	.03	0.40	4.42	<.01	0.58	6.41	<.01	0.64	7.93	<.01
New York	-0.17	-0.40	.70	-0.04	-0.12	.91	-0.32	-0.81	.42	-0.03	-0.01	.99	-0.65	-1.15	.27
Texas	0.38	3.66	<.01	0.49	4.42	<.01	0.28	2.46	.01	0.15	1.22	.22	0.31	2.24	.03

Table 6
Student Questionnaire
Student Means
Frequency of Group Class Activities

School	Comparison (1995)			SS&C 1 (1996)			SS&C 2 (1997)			SS&C 3 (1998)			SS&C 4 (1999)			SS&C 5 (2000)		
	mean	s.e.	n	mean	s.e.	n	mean	s.e.	n	mean	s.e.	n	mean	s.e.	n	mean	s.e.	n
California	3.17	0.05	292	4.18	0.04	340	4.25	0.04	314	4.10	0.04	391	4.05	0.05	249	3.59	0.07	193
Iowa	2.19	0.05	111	4.09	0.05	153	4.29	0.05	143	3.95	0.05	150	3.98	0.06	161	3.75	0.05	134
Montana	3.06	0.05	236	3.98	0.06	98	3.75	0.09	83	3.77	0.06	140	3.98	0.06	132	4.03	0.05	151
New York	2.59	0.21	13	4.31	0.15	13	4.17	0.18	14	3.67	0.26	14	3.47	0.22	15	3.08	0.21	4
Texas	2.57	0.07	210	3.49	0.08	217	3.52	0.07	202	3.04	0.08	159	2.69	0.09	148	2.90	0.13	99

1 = Never, 2 = Less than once a week, 3 = About once a week, 4 = Several times a week, 5 = Almost every day

Statistical Tests

School	1995 vs. 1996			1995 vs. 1997			1995 vs. 1998			1995 vs. 1999			1995 vs. 2000		
	Δ	t	p	Δ	t	p	Δ	t	p	Δ	t	p	Δ	t	p
California	1.00	15.23	<.01	1.08	16.03	<.01	0.92	13.54	<.01	0.88	11.78	<.01	0.42	4.75	<.01
Iowa	1.90	27.84	<.01	2.10	29.07	<.01	1.76	23.42	<.01	1.79	21.67	<.01	1.56	21.81	<.01
Montana	0.92	11.11	<.01	0.69	7.17	<.01	0.71	9.09	<.01	0.93	11.77	<.01	0.97	13.29	<.01
New York	1.72	6.74	<.01	1.58	5.81	<.01	1.08	3.23	<.01	0.88	2.84	.01	0.49	1.24	.23
Texas	0.92	9.00	<.01	0.95	9.78	<.01	0.47	4.48	<.01	0.12	1.10	.27	0.33	2.50	.01

Table 7
Student Questionnaire
Student Means
Frequency of Traditional Class Activities

School	Comparison (1995)			SS&C 1 (1996)			SS&C 2 (1997)			SS&C 3 (1998)			SS&C 4 (1999)			SS&C 5 (2000)		
	mean	s.e.	n	mean	s.e.	n	mean	s.e.	n	mean	s.e.	n	mean	s.e.	n	mean	s.e.	n
California	1.92	0.05	297	2.39	0.05	333	2.15	0.05	311	2.07	0.04	390	2.08	0.05	246	1.86	0.05	192
Iowa	1.44	0.04	110	1.82	0.05	154	1.98	0.06	143	2.04	0.05	150	1.92	0.05	158	1.89	0.05	134
Montana	2.49	0.05	235	1.97	0.07	99	1.98	0.08	82	1.84	0.05	142	2.10	0.06	131	2.04	0.06	152
New York	1.82	0.19	13	1.97	0.14	13	2.31	0.21	14	1.64	0.24	14	2.33	0.33	13	1.67	0.19	3
Texas	1.97	0.06	208	2.33	0.07	211	2.36	0.07	198	2.15	0.08	159	1.96	0.08	148	2.03	0.09	99

1 = Never, 2 = Less than once a week, 3 = About once a week, 4 = Several times a week, 5 = Almost every day

Statistical Tests

School	1995 vs. 1996			1995 vs. 1997			1995 vs. 1998			1995 vs. 1999			1995 vs. 2000		
	Δ	t	p	Δ	t	p	Δ	t	p	Δ	t	p	Δ	t	p
California	0.47	7.09	<.01	0.23	3.45	<.01	0.15	2.35	.02	0.16	2.23	.03	-0.06	-0.81	.42
Iowa	0.38	5.81	<.01	0.54	7.19	<.01	0.60	8.77	<.01	0.47	7.25	<.01	0.45	6.69	<.01
Montana	-0.52	-5.97	<.01	-0.52	-5.59	<.01	-0.65	-8.78	<.01	-0.39	-4.87	<.01	-0.46	-6.05	<.01
New York	0.16	0.65	.52	0.49	1.75	.09	-0.18	-0.57	.57	0.51	1.36	.19	-0.15	-0.38	.71
Texas	0.36	3.88	<.01	0.38	4.01	<.01	0.17	1.79	.07	-0.02	-0.16	.88	0.05	0.49	.62

Table 8
Student Questionnaire
Student Means
Frequency of Other Class Activities

School	Comparison (1995)			SS&C 1 (1996)			SS&C 2 (1997)			SS&C 3 (1998)			SS&C 4 (1999)			SS&C 5 (2000)		
	mean	s.e.	n	mean	s.e.	n	mean	s.e.	n	mean	s.e.	n	mean	s.e.	n	mean	s.e.	n
California	2.36	0.04	294	2.52	0.05	340	2.54	0.04	316	2.18	0.04	397	2.04	0.05	252	1.92	0.04	193
Iowa	1.87	0.04	110	1.79	0.05	154	2.09	0.04	141	2.09	0.04	150	1.86	0.04	159	1.93	0.05	135
Montana	2.40	0.04	234	2.00	0.05	100	1.89	0.05	83	1.78	0.03	140	1.84	0.04	134	1.85	0.04	149
New York	1.81	0.11	13	2.04	0.17	13	2.00	0.17	14	2.17	0.26	15	2.10	0.23	15	1.80	0.26	5
Texas	2.01	0.05	213	2.44	0.06	215	2.17	0.07	202	1.97	0.07	159	1.79	0.08	142	1.94	0.09	101

1 = Never, 2 = Less than once a week, 3 = About once a week, 4 = Several times a week, 5 = Almost every day

Statistical Tests

School	1995 vs. 1996			1995 vs. 1997			1995 vs. 1998			1995 vs. 1999			1995 vs. 2000		
	Δ	t	p	Δ	t	p	Δ	t	p	Δ	t	p	Δ	t	p
California	0.16	2.67	<.01	0.19	3.29	<.01	-0.17	-3.05	<.01	-0.32	-5.25	<.01	-0.44	-7.39	<.01
Iowa	-0.08	-1.37	.17	0.22	4.33	<.01	0.22	3.85	<.01	-0.01	-0.26	.79	0.06	0.91	.36
Montana	-0.40	-5.92	<.01	-0.51	-7.18	<.01	-0.62	-10.89	<.01	-0.56	-9.14	<.01	-0.55	-9.80	<.01
New York	0.23	1.13	.27	0.19	0.93	.36	0.36	1.22	.23	0.29	1.10	.28	-0.08	-0.03	.97
Texas	0.43	5.40	<.01	0.15	1.83	.07	-0.04	-0.45	.65	-0.22	-2.45	.02	-0.07	-0.73	.47

Table 9
Classroom Observations
Percent of Time Spent in Teacher-Centered Activities

School	Comparison (1995)			SS&C 1 (1996)			SS&C 2 (1997)			SS&C 3 (1998)			SS&C 4 (1999)			SS&C 5 (2000)		
	mean	s.e.	n	mean	s.e.	n	mean	s.e.	n	mean	s.e.	n	mean	s.e.	n	mean	s.e.	n
California	22.63	8.50	9	37.75	13.83	8	21.21	13.21	3	10.00	5.67	8	27.73	10.34	6	12.78	3.64	3
Iowa	9.26	6.03	6	14.09	8.82	7	11.11	11.11	2	35.19	12.14	3	0.00	0.00	5	0.00	0.00	2
Montana	69.21	7.42	7	16.67	14.76	6	0.00	0.00	3	7.08	2.27	6	16.00	13.64	5	0.00	0.00	3
New York	0.00	0.00	3	8.75	6.57	6	4.17	4.17	3	20.41	11.67	7	24.17	14.09	5	11.11	0.00	1
Texas	77.14	8.25	7	24.46	9.32	7	17.41	8.99	3	60.42	14.52	8	25.42	13.86	6	35.76	23.48	3

Statistical Tests

School	1995 vs. 1996			1995 vs. 1997			1995 vs. 1998			1995 vs. 1999			1995 vs. 2000		
	Δ	z	p	Δ	z	p	Δ	z	p	Δ	z	p	Δ	z	p
California	15.13	0.93	.35	-1.41	-0.09	.93	-12.63	-1.24	.22	5.10	0.38	.70	-9.85	-1.07	.28
Iowa	4.83	0.45	.65	1.85	0.15	.88	25.93	1.91	.06	-9.26	-1.54	.12	-9.26	-1.54	.12
Montana	-52.54	-3.18	<.01	-69.21	-9.33	<.01	-62.13	-8.01	<.01	-53.21	-3.43	<.01	-69.21	-9.33	<.01
New York	8.75	1.33	.18	4.17	1.00	.32	20.41	1.75	.08	24.17	1.71	.09	Can't be calculated		
Texas	-52.68	-4.23	<.01	-59.74	-4.90	<.01	-16.73	-1.00	.32	-51.72	-3.21	<.01	-41.39	-1.66	.10

Table 10
Classroom Observations
Percent of Time Spent in Teacher- and Student-Centered Activities

School	Comparison (1995)			SS&C 1 (1996)			SS&C 2 (1997)			SS&C 3 (1998)			SS&C 4 (1999)			SS&C 5 (2000)		
	mean	s.e.	n	mean	s.e.	n	mean	s.e.	n	mean	s.e.	n	mean	s.e.	n	mean	s.e.	n
California	27.60	8.94	9	31.38	9.44	8	31.21	2.69	3	16.25	5.96	8	16.36	5.55	6	43.33	21.86	3
Iowa	61.99	12.54	6	19.01	4.52	7	33.33	11.11	2	11.11	6.42	3	42.22	13.79	5	10.56	0.56	2
Montana	15.32	7.40	7	16.94	7.77	6	3.70	3.70	3	12.08	4.00	6	22.00	10.20	5	16.67	8.82	3
New York	76.39	7.65	3	44.07	16.24	6	23.61	11.87	3	21.50	10.63	7	41.11	10.95	5	0.00	0.00	1
Texas	5.48	4.25	7	10.95	6.21	7	43.70	17.47	3	34.15	14.59	8	31.75	13.85	6	41.52	10.84	3

Statistical Tests

School	1995 vs. 1996			1995 vs. 1997			1995 vs. 1998			1995 vs. 1999			1995 vs. 2000		
	Δ	z	p	Δ	z	p	Δ	z	p	Δ	z	p	Δ	z	p
California	3.78	0.29	.77	3.61	0.39	.70	-11.35	-1.06	.29	-11.23	-1.07	.28	15.74	0.67	.50
Iowa	-42.98	-3.22	<.01	-28.66	-1.71	.09	-50.88	-3.61	<.01	-19.77	-1.06	.29	-51.44	-4.10	<.01
Montana	1.62	0.15	.88	-11.62	-1.40	.16	-3.24	-0.39	.70	6.68	0.53	.60	1.34	0.12	.90
New York	-32.31	-1.80	.07	-52.78	-3.74	<.01	-54.89	-4.19	<.01	-35.28	-2.64	.01	-76.39	-9.99	<.01
Texas	5.48	0.73	.47	38.23	2.13	.03	28.68	1.89	.06	26.27	1.81	.07	36.04	3.01	<.01

Table 11
Classroom Observations
Percent of Time Spent in Student-Centered Activities

School	Comparison (1995)			SS&C 1 (1996)			SS&C 2 (1997)			SS&C 3 (1998)			SS&C 4 (1999)			SS&C 5 (2000)		
	mean	s.e.	n	mean	s.e.	n	mean	s.e.	n	mean	s.e.	n	mean	s.e.	n	mean	s.e.	n
California	26.32	10.71	9	4.86	3.23	8	31.82	9.46	3	48.75	10.60	8	17.88	8.61	6	25.00	25.00	3
Iowa	1.85	1.85	6	37.30	10.89	7	38.89	5.56	2	37.96	9.12	3	40.00	13.43	5	62.78	7.22	2
Montana	4.76	4.76	7	51.67	13.02	6	89.26	0.37	3	70.42	5.02	6	50.00	12.25	5	76.67	8.82	3
New York	4.17	4.17	3	22.59	10.68	6	53.24	18.91	3	47.62	19.05	7	20.00	12.37	5	77.78	0.00	1
Texas	7.38	4.63	7	38.57	11.13	7	38.89	20.03	3	0.00	0.00	8	35.35	16.01	6	13.33	13.33	3

Statistical Tests

School	1995 vs. 1996			1995 vs. 1997			1995 vs. 1998			1995 vs. 1999			1995 vs. 2000		
	Δ	z	p	Δ	z	p	Δ	z	p	Δ	z	p	Δ	z	p
California	-21.46	-1.92	.05	5.50	0.38	.70	22.43	1.49	.14	-8.44	-0.61	.54	-1.32	-0.05	.96
Iowa	35.45	3.21	<.01	37.04	6.32	<.01	36.11	3.88	<.01	38.15	2.81	<.01	60.93	8.17	<.01
Montana	46.90	3.38	<.01	84.50	17.69	<.01	65.65	9.49	<.01	45.24	3.44	<.01	71.90	7.17	<.01
New York	18.43	1.61	.11	49.07	2.53	.01	43.45	2.23	.03	15.83	1.21	.22	73.61	17.67	<.01
Texas	31.19	2.59	.01	31.51	1.53	.13	-7.38	-1.60	.11	27.97	1.68	.09	5.95	0.42	.67

Table 12
Inclination, Motivation & Attitudes*
Percentage of students who replied "YES"

School	Comparison (1995)			SS&C 1 (1996)			SS&C 2 (1997)			SS&C 3 (1998)			SS&C 4 (1999)			SS&C 4 (2000)		
	%	s.e.	n	%	s.e.	n	%	s.e.	n	%	s.e.	n	%	s.e.	n	%	s.e.	n
California	72.72	3.14	75	65.22	2.89	96	62.28	3.10	83	61.40	2.59	113	65.45	3.60	59	62.05	4.04	45
Iowa	57.92	5.21	34	54.99	4.01	54	86.40	2.06	82	85.42	2.11	67	85.55	2.14	82	86.95	1.99	56
Montana	60.15	4.16	50	68.97	4.33	29	75.77	6.73	20	72.22	4.22	36	62.53	5.87	31	65.75	3.83	42
New York	79.49	5.13	6	94.87	2.56	3	78.85	3.68	4	82.05	17.95	3	61.54	22.86	4	50.00	26.92	2
Texas	58.43	3.44	57	79.78	2.58	62	76.28	3.04	60	73.48	3.91	38	66.78	5.82	22	65.53	4.98	27

1 = Yes, 0 = No

* This variable is the result of the linear combination of the items addressing the inclination to continue studying science, motivation toward science and attitude toward science. Attitude scores were recoded from a Likert-type scale to a yes/no response before combining them with the other data.

Statistical Tests

School	1995 vs. 1996			1995 vs. 1997			1995 vs. 1998			1995 vs. 1999			1995 vs. 2000		
	Δ	z	p	Δ	z	p	Δ	z	p	Δ	z	p	Δ	z	p
California	-7.49	-1.76	.08	-10.44	-2.36	.02	-11.32	-2.78	.01	-7.27	-1.52	.13	-10.67	-2.08	.04
Iowa	-2.93	-0.45	.65	28.48	5.09	<.01	27.50	4.89	<.01	27.63	4.91	<.01	32.03	5.75	<.01
Montana	8.81	1.47	.14	15.62	1.97	.05	12.07	2.04	.04	2.38	0.33	.73	5.60	0.99	.32
New York	15.38	2.68	.01	-0.64	-0.10	.92	2.56	0.14	.89	-17.95	-0.77	.44	-29.49	-1.08	.28
Texas	21.34	4.96	<.01	17.88	3.89	<.01	15.05	2.89	<.01	8.35	1.23	.22	7.09	1.17	.24

Table 13
Lab Skills Performance Test
Student Means
Percent Correct by Total Score and Station

School	Comparison (1995)			SS&C 1 (1996)			SS&C 2 (1997)			SS&C 3 (1998)			SS&C 4 (1999)			SS&C 5 (2000)		
	mean	s.e.	n	mean	s.e.	n	mean	s.e.	n	mean	s.e.	n	mean	s.e.	n	mean	s.e.	n
California	66.40	2.87	26	61.30	2.94	25	55.38	5.24	16	63.90	2.99	27	60.16	3.23	26	60.53	3.11	29
Iowa	70.05	2.20	29	74.37	2.23	27	72.49	2.98	26	75.92	2.45	30	76.62	3.00	30	81.11	1.43	30
Montana	68.34	3.35	27	76.80	2.33	28	82.05	2.73	14	75.39	4.10	15	77.28	2.88	24	77.81	2.64	15
New York	40.97	5.47	12	59.14	5.83	10	63.27	6.14	9	59.88	4.12	17	43.88	2.80	21	57.97	2.15	7
Texas	40.61	3.18	10	50.47	3.30	16	42.93	5.31	12	50.20	3.19	28	47.02	2.83	26	50.28	3.96	19

Statistical Tests

School	1995 vs. 1996			1995 vs. 1997			1995 vs. 1998			1995 vs. 1999			1995 vs. 2000		
	Δ	z	p	Δ	z	p	Δ	z	p	Δ	z	p	Δ	z	p
California	-5.10	-1.24	.22	-11.02	-1.85	.06	-2.51	-0.61	.54	-6.25	-1.45	.15	-5.88	-1.39	.16
Iowa	4.32	1.38	.17	2.44	0.66	.51	5.86	1.78	.08	6.56	1.77	.08	11.06	4.21	<.01
Montana	8.46	2.07	.04	13.17	3.17	<.01	7.05	1.33	.18	8.94	2.02	.04	9.47	2.22	.03
New York	18.17	2.27	.02	22.30	2.71	.01	18.91	2.76	.01	2.91	0.47	.64	17.00	2.89	<.01
Texas	9.87	2.15	.03	2.32	0.38	.70	9.59	2.13	.03	6.41	1.51	.13	9.67	1.91	.06

Table 14
Science Literacy Test
Student Means
Percent Correct on Multiple Choice Items

School	Comparison (1995)			SS&C 1 (1996)			SS&C 2 (1997)			SS&C 3 (1998)			SS&C 4 (1999)			SS&C 5 (2000)		
	mean	s.e.	n	mean	s.e.	n	mean	s.e.	n	mean	s.e.	n	mean	s.e.	n	mean	s.e.	n
California	47.14	0.81	324	47.52	0.83	332	50.14	0.77	360	50.12	0.84	299	47.76	0.95	220	49.70	1.02	181
Iowa	67.32	0.83	194	59.88	1.04	189	62.78	0.85	185	61.96	0.78	173	60.50	0.86	187	60.22	0.98	161
Montana	61.39	0.81	288	61.00	1.20	126	60.40	1.36	91	61.85	1.02	149	61.58	1.02	156	61.55	1.10	158
New York	45.43	2.68	26	51.33	2.19	31	48.45	1.85	41	51.90	3.02	23	48.61	5.18	9	46.34	3.10	14
Texas	42.22	0.73	216	43.85	1.04	158	37.08	0.80	162	42.54	0.94	142	37.55	1.39	55	33.22	1.19	71

Statistical Tests

School	1995 vs. 1996			1995 vs. 1997			1995 vs. 1998			1995 vs. 1999			1995 vs. 2000		
	Δ	z	p	Δ	z	p	Δ	z	p	Δ	z	p	Δ	z	p
California	0.37	0.32	.75	3.00	2.69	.01	2.98	2.57	.01	0.62	0.50	.62	2.55	1.96	.05
Iowa	-7.44	-5.56	<.01	-4.54	-3.82	<.01	-5.36	-4.70	<.01	-6.82	-5.70	<.01	-7.10	-5.52	<.01
Montana	-0.39	-0.27	.79	-0.99	-0.63	.53	0.46	0.35	.73	0.19	0.14	.89	0.16	0.12	.90
New York	5.90	1.70	.09	3.01	0.93	.35	6.47	1.60	.11	3.18	0.55	.58	0.91	0.22	.83
Texas	1.63	1.29	.20	-5.15	-4.75	<.01	0.31	0.26	.79	-4.68	-2.98	<.01	-9.00	-6.45	<.01

Table 15
Science Literacy Test
Student Means
Percent Correct on Open-Ended Questions

School	Comparison (1995)			SS&C 1 (1996)			SS&C 2 (1997)			SS&C 3 (1998)			SS&C 4 (1999)			SS&C 5 (2000)		
	mean	s.e.	n	mean	s.e.	n	mean	s.e.	n	mean	s.e.	n	mean	s.e.	n	mean	s.e.	n
California	30.70	1.22	320	35.28	2.82	47	34.85	4.95	22	47.08	5.28	20	32.16	2.32	85	27.67	2.36	50
Iowa	54.25	1.55	151	44.34	2.68	53	56.32	3.83	29	52.02	2.95	33	48.52	2.47	62	47.62	2.50	63
Montana	50.95	1.22	289	53.79	2.86	33	56.52	4.47	23	41.67	4.23	19	51.82	2.52	55	41.67	2.97	50
New York	23.66	3.19	31	34.14	3.22	31	46.21	4.82	11	35.71	4.66	14	25.00	4.42	22	35.42	3.82	20
Texas	20.08	1.04	215	21.08	4.05	17	16.18	2.81	17	22.78	2.65	30	9.55	1.28	89	10.19	2.37	27

Statistical Tests

School	1995 vs. 1996			1995 vs. 1997			1995 vs. 1998			1995 vs. 1999			1995 vs. 2000		
	Δ	z	p	Δ	z	p	Δ	z	p	Δ	z	p	Δ	z	p
California	4.58	1.49	.14	4.15	0.81	.42	16.38	3.02	<.01	1.45	0.55	.58	-3.04	-1.14	.25
Iowa	-9.91	-3.20	<.01	2.07	0.50	.62	-2.23	-0.67	.50	-5.73	-1.96	.05	-6.63	-2.26	.02
Montana	2.84	0.91	.36	5.57	1.20	.23	-9.28	-2.11	.03	0.87	0.31	.76	-9.28	-2.89	<.01
New York	10.48	2.31	.02	22.56	3.91	<.01	12.06	2.14	.03	1.34	0.25	.80	11.76	2.36	.02
Texas	1.00	0.24	.81	-3.90	-1.30	.19	2.70	0.95	.34	-10.53	-6.37	<.01	-9.89	-3.82	<.01

Table 16
California
Student Questionnaire
Student Means
Percent of Time Spent by Class Activities in SS&C and Comparison Classes

Activity	Comparison (1995)		SS&C 1 (1996)		SS&C 2 (1997)		SS&C 3 (1998)		SS&C 4 (1999)		SS&C 5 (2000)	
	n = 274		n = 315		n = 293		n = 351		n = 233		n = 186	
	mean	s.e.	mean	s.e.	mean	s.e	mean	s.e	mean	s.e	mean	s.e
Inquiry	29.70	0.39	28.21	0.31	27.89	0.34	28.91	0.34	29.79	0.44	30.57	0.49
Group	29.94	0.34	33.32	0.32	34.70	0.35	35.18	0.37	35.15	0.43	33.66	0.50
Traditional	18.00	0.34	18.64	0.28	16.96	0.31	17.48	0.28	17.58	0.38	17.34	0.36
Other	22.37	0.32	19.82	0.27	20.44	0.27	18.43	0.25	17.49	0.31	18.43	0.40

Statistical Tests

Activity	1995 vs. 1996			1995 vs. 1997			1995 vs. 1998			1995 vs. 1999			1995 vs. 2000		
	Δ	z	p	Δ	z	p	Δ	z	p	Δ	z	p	Δ	z	p
Inquiry	-1.49	-2.97	<.01	-1.81	-3.50	<.01	-0.79	-1.53	.13	0.08	0.14	.89	0.87	1.39	.16
Group	3.39	7.28	<.01	4.77	9.80	<.01	5.24	10.47	<.01	5.21	9.46	<.01	3.72	6.17	<.01
Traditional	0.65	1.45	.15	-1.03	-2.23	.03	-0.51	-1.16	.25	-0.42	-0.82	.41	-0.65	-1.31	.19
Other	-2.54	-6.02	<.01	-1.92	-4.58	<.01	-3.93	-9.61	<.01	-4.88	-7.03	<.01	-3.94	-7.70	<.01

Table 17
California
Student Questionnaire
Student Means
Frequency of Class Activities in SS&C and Comparison Classes

Activity	Comparison (1995)			SS&C 1 (1996)			SS&C 2 (1997)			SS&C 3 (1998)			SS&C 4 (1999)			SS&C 5 (2000)		
	mean	s.e.	n	mean	s.e.	n	mean	s.e.	n	mean	s.e.	n	mean	s.e.	n	mean	s.e.	n
Inquiry	3.17	0.06	281	3.58	0.05	330	3.49	0.05	306	3.42	0.05	381	3.46	0.06	246	3.29	0.07	191
Group	3.17	0.05	292	4.18	0.04	340	4.25	0.04	314	4.10	0.04	391	4.05	0.05	249	3.59	0.07	193
Traditional	1.92	0.05	297	2.39	0.05	333	2.15	0.05	311	2.07	0.04	390	2.08	0.05	246	1.86	0.05	192
Other	2.36	0.04	294	2.52	0.05	340	2.54	0.04	316	2.18	0.04	397	2.04	0.04	252	1.92	0.04	193

1 = Never, 2 = Less than once a week, 3 = About once a week, 4 = Several times a week, 5=Almost every day

Statistical Tests

Activity	1995 vs. 1996			1995 vs. 1997			1995 vs. 1998			1995 vs. 1999			1995 vs. 2000		
	Δ	t	p	Δ	t	p	Δ	t	p	Δ	t	p	Δ	t	p
Inquiry	0.42	5.46	<.01	0.32	4.12	<.01	0.25	3.13	<.01	0.29	3.37	<.01	0.13	1.37	.17
Group	1.00	15.23	<.01	1.08	16.03	<.01	0.92	13.54	<.01	0.88	11.78	<.01	0.42	4.75	<.01
Traditional	0.47	7.09	<.01	0.23	3.45	<.01	0.15	2.35	.02	0.16	2.23	.03	-0.06	-0.81	.42
Other	0.16	2.67	<.01	0.19	3.29	<.01	-0.17	-3.05	<.01	-0.32	-5.25	<.01	-0.44	-7.39	<.01

Table 18
California
Student Questionnaire
Student Means
Frequency of Inquiry Class Activities

Activity	Comparison (1995)		SS&C 1 (1996)		SS&C 2 (1997)		SS&C 3 (1998)		SS&C 4 (1999)		SS&C 5 (2000)	
	n = 281		n = 330		n = 306		n = 381		n = 246		n = 191	
	mean	s.e.	mean	s.e.	mean	s.e	mean	s.e	mean	s.e	mean	s.e
Total (Combined Inquiry)	3.17	0.06	3.58	0.05	3.49	0.05	3.42	0.05	3.46	0.06	3.29	0.07
Demonstration of a scientific principle	3.33	0.07	3.59	0.06	3.45	0.07	3.42	0.06	3.55	0.08	3.62	0.08
Ask students to suggest hypotheses	3.23	0.07	3.48	0.07	3.24	0.08	3.41	0.07	3.51	0.09	3.24	0.10
Ask students to interpret data	2.93	0.07	3.63	0.07	3.67	0.07	3.48	0.07	3.47	0.09	3.11	0.10
Relate previous work to current topic	3.13	0.07	3.63	0.06	3.58	0.07	3.36	0.07	3.31	0.08	3.22	0.09

1 = Never, 2 = Less than once a week, 3 = About once a week, 4 = Several times a week, 5 = Almost every day

Statistical Tests

Activity	1995 vs. 1996			1995 vs. 1997			1995 vs. 1998			1995 vs. 1999			1995 vs. 2000		
	Δ	t	p	Δ	t	p	Δ	t	p	Δ	t	p	Δ	t	p
Total (Combined Inquiry)	0.42	5.46	<.01	0.32	4.12	<.01	0.25	3.13	<.01	0.29	3.37	<.01	0.13	1.37	.17
Demonstration of a scientific principle	0.26	2.81	<.01	0.12	1.24	.22	0.09	0.92	.36	0.22	2.07	.04	0.29	2.73	<.01
Ask students to suggest hypotheses	0.25	2.54	.01	0.02	0.19	.85	0.18	1.84	.07	0.28	2.51	0.01	0.01	0.12	.91
Ask students to interpret data	0.70	6.93	<.01	0.74	7.30	<.01	0.55	5.37	<.01	0.54	4.85	<.01	0.18	1.48	.14
Relate previous work to current topic	0.50	5.21	<.01	0.45	4.49	<.01	0.23	2.25	0.03	0.18	1.57	.12	0.09	0.74	.46

Table 19
California
Student Questionnaire
Student Means
Frequency of Group Class Activities

Activity	Comparison (1995)		SS&C 1 (1996)		SS&C 2 (1997)		SS&C 3 (1998)		SS&C 4 (1999)		SS&C 5 (2000)	
	n = 292		n= 340		n = 314		n = 391		n = 249		n = 193	
	mean	s.e.	mean	s.e.	mean	s.e	mean	s.e	mean	s.e	mean	s.e
Total (Combined Group)	3.17	0.05	4.18	0.04	4.25	0.04	4.10	0.04	4.05	0.05	3.59	0.07
Do experiments with other students	2.90	0.06	4.31	0.06	4.42	0.06	4.07	0.07	4.13	0.08	3.59	0.09
Work in groups	3.70	0.07	4.69	0.04	4.77	0.04	4.66	0.04	4.61	0.05	4.18	0.08
Share results from experiments	2.93	0.07	3.52	0.07	3.56	0.08	3.52	0.07	3.38	0.09	2.98	0.10

1 = Never, 2 = Less than once a week, 3 = About once a week, 4 = Several times a week, 5 = Almost every day

Statistical Tests

Activity	1995 vs. 1996			1995 vs. 1997			1995 vs. 1998			1995 vs. 1999			1995 vs. 2000		
	Δ	t	p	Δ	t	p	Δ	t	p	Δ	t	p	Δ	t	p
Total (Combined Group)	1.00	15.23	<.01	1.08	16.03	<.01	0.92	13.54	<.01	0.88	11.78	<.01	0.42	4.75	<.01
Do experiments with other students	1.41	16.45	<.01	1.52	17.04	<.01	1.18	12.20	<.01	1.23	12.49	<.01	0.69	6.36	<.01
Work in groups	0.99	12.47	<.01	1.07	13.24	<.01	0.96	12.32	<.01	0.91	10.00	<.01	0.49	4.50	<.01
Share results from experiments	0.60	6.28	<.01	.64	6.15	<.01	0.59	6.13	<.01	0.46	4.19	<.01	0.06	0.50	.62

Table 20
California
Student Questionnaire
Student Means
Frequency of Traditional Class Activities

Activity	Comparison (1995)		SS&C 1 (1996)		SS&C 2 (1997)		SS&C 3 (1998)		SS&C 4 (1999)		SS&C 5 (2000)	
.	n = 297		n = 333		n = 311		n = 390		n = 246		n = 192	
	mean	s.e.	mean	s.e	mean	s.e	mean	s.e	mean	s.e	mean	s.e
Total (Combined Traditional)	1.92	0.05	2.39	0.05	2.15	0.05	2.07	0.04	2.08	0.05	1.86	0.05
Read articles on science	1.87	0.06	2.52	0.06	2.02	0.06	2.03	0.05	1.87	0.06	1.92	0.07
Do oral or written reports	1.58	0.05	1.99	0.06	1.91	0.06	1.76	0.05	1.69	0.07	1.37	0.05
Read other science materials	2.32	0.08	2.64	0.07	2.54	0.08	2.46	0.06	2.66	0.09	2.31	0.09

1 = Never, 2 = Less than once a week, 3 = About once a week, 4 = Several times a week, 5 = Almost every day

Statistical Tests

Activity	1995 vs. 1996			1995 vs. 1997			1995 vs. 1998			1995 vs. 1999			1995 vs. 2000		
	Δ	t	p	Δ	t	p	Δ	t	p	Δ	t	p	Δ	t	p
Total (Combined Traditional)	0.47	7.09	<.01	0.23	3.45	<.01	0.15	2.35	.02	0.16	2.23	.03	-0.06	-0.81	.42
Read articles on science	0.66	7.88	<.01	0.15	1.84	.07	0.16	2.12	.03	0.03	0.03	.97	0.05	0.57	.57
Do oral or written reports	0.41	5.28	<.01	0.33	4.28	<.01	0.18	2.50	.01	0.11	1.28	.20	-0.21	-2.85	<.01
Read other science materials	0.32	3.06	<.01	0.23	2.12	.04	0.14	1.47	.14	0.34	2.89	<.01	-0.06	-0.05	.96

Table 21
California
Student Questionnaire
Student Means
Frequency of Other Class Activities

Activity	Comparison (1995)		SS&C 1 (1996)		SS&C 2 (1997)		SS&C 3 (1998)		SS&C 4 (1999)		SS&C 5 (2000)	
	n = 294		n = 340		n = 316		n = 397		n = 252		n = 193	
	mean	s.e.	mean	s.e	mean	s.e	mean	s.e	mean	s.e	mean	s.e
Total (Combined Other)	2.36	0.04	2.52	0.05	2.54	0.04	2.18	0.04	2.04	0.05	1.92	0.04
Watch films, slides, or videos	3.06	0.05	2.92	0.05	2.81	0.05	2.61	0.04	2.38	0.05	2.61	0.06
Go outside for class instruction	1.66	0.05	2.12	0.05	2.28	0.05	1.77	0.05	1.69	0.05	1.22	0.04

1 = Never, 2 = Less than once a week, 3 = About once a week, 4 = Several times a week, 5 = Almost every day

Statistical Tests

Activity	1995 vs. 1996			1995 vs. 1997			1995 vs. 1998			1995 vs. 1999			1995 vs. 2000		
	Δ	t	p	Δ	t	p	Δ	t	p	Δ	t	p	Δ	t	p
Total (Combined Other)	0.16	2.67	<.01	0.19	3.29	<.01	-0.17	-3.05	<.01	-0.32	-5.25	<.01	-0.44	-7.39	<.01
Watch films, slides, or videos	-0.14	-1.87	.06	-0.24	-3.48	<.01	-0.45	-6.51	<.01	-0.68	-8.95	<.01	-0.45	-5.64	<.01
Go outside for class instruction	0.46	6.37	<.01	0.62	8.88	<.01	0.11	1.55	.12	0.03	0.41	.68	-0.44	-6.46	<.01

Table 22
California
Teacher Questionnaire
Individual Means
Frequency of Class Activities

Activity	**Comparison (1995)**		**SS&C 1 (1996)**		**SS&C 2 (1997)**		**SS&C 3 (1998)**		**SS&C 4 (1999)**		**SS&C 5 (2000)**	
	n = 6		n = 6		n = 6		n = 5		n = 5		n = 3	
	mean	s.e.	mean	s.e.	mean	s.e.	mean	s.e.	mean	s.e.	mean	s.e.
Inquiry	3.21	0.32	4.08	0.26	3.92	0.14	4.30	0.24	4.20	0.12	3.83	0.08
Traditional	1.83	0.14	2.22	0.14	2.44	0.16	2.33	0.21	2.13	0.08	1.89	0.11

1 = Never, 2 = Less than once a week, 3 = About once a week, 4 = Several times a week, 5 = Almost every day

Statistical Tests

Activity	**1995 vs. 1996**			**1995 vs. 1997**			**1995 vs. 1998**			**1995 vs. 1999**			**1995 vs. 2000**		
	Δ	t	p	Δ	t	p	Δ	t	p	Δ	t	p	Δ	t	p
Inquiry	0.88	2.12	.06	0.71	2.04	.07	1.09	2.63	.03	0.99	2.68	.03	0.63	1.33	.23
Traditional	0.39	1.94	.08	0.61	2.80	.02	0.50	2.02	.07	0.30	1.72	.12	0.06	0.25	.81

Table 23
California
Teacher Questionnaire
Individual Means
Frequency of Inquiry Class Activities

Activity	Comparison (1995)		SS&C 1 (1996)		SS&C 2 (1997)		SS&C 3 (1998)		SS&C 4 (1999)		SS&C 5 (2000)	
	n = 6		n = 6		n = 6		n = 5		n = 5		n = 3	
	mean	s.e.	mean	s.e.	mean	s.e.	mean	s.e.	mean	s.e.	mean	s.e.
Total (Combined Inquiry)	3.21	0.32	4.08	0.26	3.92	0.14	4.30	0.24	4.20	0.12	3.83	0.08
Do experiments	3.83	0.17	4.33	0.21	4.50	0.22	4.60	0.24	4.60	0.24	4.00	0.00
Ask for reasons for the results of experiments	3.00	0.45	4.17	0.48	4.00	0.26	4.40	0.24	3.80	0.20	4.33	0.33
Ask students to suggest hypotheses	3.00	0.37	4.00	0.26	3.00	0.37	4.00	0.55	4.40	0.24	3.00	0.58
Ask students to interpret data	3.00	0.45	3.83	0.31	4.17	0.17	4.20	0.37	4.00	0.00	4.00	0.00

1 = Never, 2 = Less than once a week, 3 = About once a week, 4 = Several times a week, 5 = Almost every day

Statistical Tests

Activity	1995 vs. 1996			1995 vs. 1997			1995 vs. 1998			1995 vs. 1999			1995 vs. 2000		
	Δ	t	p	Δ	t	p	Δ	t	p	Δ	t	p	Δ	t	p
Total (Combined Inquiry)	0.88	2.12	.06	0.71	2.04	.07	1.09	2.63	.03	0.99	2.68	.03	0.63	1.33	.23
Do experiments	0.50	1.86	.09	0.67	2.39	.04	0.77	2.66	.03	0.77	2.66	.03	0.17	0.68	.52
Ask for reasons for the results of experiments	1.17	1.78	.11	1.00	1.94	.08	1.40	2.59	.03	0.80	1.52	.16	1.33	1.93	.10
Ask students to suggest hypotheses	1.00	2.24	.05	0.00	0.00	1.00	1.00	1.57	.15	1.40	3.04	.01	0.00	0.00	1.00
Ask students to interpret data	0.83	1.54	.16	1.17	2.45	.04	1.20	2.00	.08	1.00	.02	.07	1.00	1.53	.17

Table 24
California
Teacher Questionnaire
Individual Means
Frequency of Traditional Class Activities

Activity	Comparison (1995)		SS&C 1 (1996)		SS&C 2 (1997)		SS&C 3 (1998)		SS&C 4 (1999)		SS&C 5 (2000)	
	n = 6		n = 6		n = 6		n = 5		n = 5		n = 3	
	mean	s.e.	mean	s.e.	mean	s.e.	mean	s.e.	mean	s.e.	mean	s.e.
Total (Combined Traditional)	1.83	0.14	2.22	0.14	2.44	0.16	2.33	0.21	2.13	0.08	1.89	0.11
Read articles on science	1.50	0.22	2.50	0.22	2.33	0.21	2.00	0.00	2.20	0.20	2.33	0.33
Do oral or written reports	1.50	0.22	1.83	0.17	2.50	0.50	2.80	0.58	2.20	0.20	1.33	0.33
Read other science materials	2.50	0.22	2.33	0.33	2.50	0.22	2.20	0.20	2.00	0.00	2.00	0.00

1 = Never, 2 = Less than once a week, 3 = About once a week, 4 = Several times a week, 5 = Almost every day

Statistical Tests

Activity	1995 vs. 1996			1995 vs. 1997			1995 vs. 1998			1995 vs. 1999			1995 vs. 2000		
	Δ	t	p	Δ	t	p	Δ	t	p	Δ	t	p	Δ	t	p
Total (Combined Traditional)	0.39	1.94	.08	0.61	2.80	.02	0.50	2.02	.07	0.30	1.72	.12	0.06	0.25	.81
Read articles on science	1.00	3.16	.01	0.83	2.71	.02	0.50	2.02	.07	0.70	2.29	.05	0.83	2.12	.07
Do oral or written reports	0.33	1.20	.26	1.00	1.83	.10	1.30	2.24	.05	0.70	2.29	.05	-0.17	-0.42	.69
Read other science materials	-0.17	-0.42	.69	0.00	0.00	1.00	-0.30	-0.98	.35	-0.50	-2.02	.07	-0.50	-1.53	.17

Table 25
California
Classroom Observations
Percent Time Spent by Teaching Style

Style	Comparison (1995)		SS&C 1 (1996)		SS&C 2 (1997)		SS&C 3 (1998)		SS&C 4 (1999)		SS&C 5 (2000)	
	n = 9		n = 8		n = 3		n = 8		n = 6		n = 3	
	freq.	%	freq.	%	freq.	%	freq.	%	freq.	%	freq.	%
Teacher-Centered	21	22.58	33	41.77	7	21.88	8	10.00	17	26.98	4	12.50
Student- & Teacher-Centered	26	27.96	24	30.38	10	31.25	13	16.25	10	15.87	13	40.63
Student-Centered	24	25.81	3	3.80	10	31.25	39	48.75	11	17.46	9	28.13
Administrative	15	16.13	11	13.92	5	15.63	10	12.50	7	11.11	0	0.00
Other activities	7	7.53	8	10.13	0	0.00	10	12.50	18	28.57	6	18.75

Statistical Tests

Style	1995 vs. 1996		1995 vs. 1997		1995 vs. 1998		1995 vs. 1999		1995 vs. 2000	
	χ^2	p	χ^2	p	χ^2	p	χ^2	p	χ^2	p
Teacher-Centered										
Student- & Teacher-Centered										
Student-Centered										
Administrative										
Other activities										
	16.65	<.01	2.80	>.05	14.34	<.01	14.85	<.01	10.53	<.05

χ^2 critical values: At .05 = 9.49; at .025 = 11.14; at .01 = 13.28

Table
California
Classroom Observations
Frequency of Student Involvement and Type of Instruction

Variable *Response*	**Comparison (1995)**		**SS&C 1 (1996)**		**SS&C 2 (1997)**		**SS&C 3 (1998)**		**SS&C 4 (1999)**		**SS&C 5 (2000)**	
	n = 7		n = 8		n = 3		n = 8		n = 6		n = 3	
	freq.	%	freq.	%	freq.	%	freq.	%	freq.	%	freq.	%
Student Involvement												
Almost always	2	28.6	1	12.5	1	33.3	4	50.0	3	50.0	1	33.3
Sometimes	4	57.1	7	87.5	2	66.7	4	50.0	2	33.3	2	66.7
Almost never	1	14.3	0	0.0	0	0.0	0	0.0	1	16.7	0	0.0
Type of Instruction												
Traditional	8	88.9	6	85.7	2	66.7	2	25.0	3	50.0	0	0.0
Mixed	0	0.0	1	14.3	1	33.3	5	62.5	3	50.0	2	66.7
Inquiry	1	11.1	0	0.0	0	0.0	1	12.5	0	0.0	1	33.3

Statistical Tests

Variable	1995 vs. 1996		1995 vs. 1997		1995 vs. 1998		1995 vs. 1999		1995 vs. 2000	
	χ^2	p	χ^2	p	χ^2	p	χ^2	p	χ^2	p
Student Involvement	2.09	.35	0.48	.79	1.61	.45	0.79	.67	0.48	.79
Type of Instruction	2.07	.36	3.47	.18	8.57	.01	5.91	.05	9.33	<.01

Table 27
California
Curriculum Verification
Number of Weeks Spent on Science Topics

Standard	Comparison (1995)		SS&C 1 (1996)		SS&C 2 (1997)		SS&C 3 (1998)		SS&C 4 (1999)		SS&C 5 (2000)	
	classes affected = 18		classes affected = 20		classes affected = 18		classes affected = 21		classes affected = 16		classes affected = 11	
	weeks	%	weeks	%	weeks	%	weeks	%	weeks	%	weeks	%
Chemistry	9.0	26.47	8.5	37.78	8.5	25.37	12.5	36.76	9.5	28.36	8.5	24.64
Biology	0.0	0.00	6.5	28.89	5.5	16.42	7.0	20.59	6.5	19.40	7.5	21.74
Earth & Space Sciences	11.0	32.35	3.5	15.56	4.0	11.94	3.0	8.82	3.0	8.96	4.0	11.59
Physics	3.0	8.82	14.0	62.22	15.5	42.27	10.5	30.88	10.5	31.34	10.0	28.99
Measurement	5.0	14.71	0.0	0.00	0.0	0.00	1.0	2.94	4.0	11.94	4.5	13.04
Science & Society	3.0	8.82	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00
Miscellaneous	3.0	8.82	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00

Table 28
California
Learning Environment Inventory
Student Means

Subscale	Comparison (1995)		SS&C 1 (1996)		SS&C 2 (1997)		SS&C 3 (1998)		SS&C 4 (1999)		SS&C 5 (2000)	
	n = 303		n = 351		n = 322		n = 415		n = 258		n = 199	
	mean	s.e.	mean	s.e.	mean	s.e.	mean	s.e.	mean	s.e.	mean	s.e.
Difficulty	2.99	0.04	2.79	0.04	2.82	0.04	2.75	0.04	2.74	0.05	2.69	0.06
Relevance	3.38	0.04	3.42	0.04	3.29	0.04	3.32	0.04	3.41	0.05	3.41	0.05
Critical Voice	3.62	0.05	3.67	0.04	3.53	0.05	3.60	0.04	3.55	0.05	3.50	0.06
Involvement	3.55	0.04	3.63	0.04	3.56	0.04	3.54	0.04	3.59	0.05	3.60	0.05
Sequencing	2.54	0.05	2.68	0.05	2.89	0.05	2.73	0.04	2.71	0.05	2.55	0.06
Experimenting	2.47	0.04	2.65	0.04	2.68	0.04	2.64	0.04	2.58	0.05	2.52	0.05

1 = Almost Never, 2 = Seldom, 3 = Sometimes, 4 = Often, 5 = Almost Always

Statistical Tests

Subscale	1995 vs. 1996			1995 vs. 1997			1995 vs. 1998			1995 vs. 1999			1995 vs. 2000		
	Δ	t	p	Δ	t	p	Δ	t	p	Δ	t	p	Δ	t	p
Difficulty	-0.20	-3.39	<.01	-0.17	-2.84	<.01	-0.24	-4.26	<.01	-0.24	-3.73	<.01	-0.30	-4.31	<.01
Relevance	0.04	0.72	.47	-0.09	-1.46	.15	-0.06	-1.09	.27	0.03	0.44	.66	0.03	0.40	.69
Critical Voice	0.05	0.84	.40	-0.09	-1.39	.17	-0.02	-0.28	.78	-0.07	-0.98	.33	-0.12	-1.62	.11
Involvement	0.08	1.42	.16	0.01	0.26	.80	-0.07	-0.13	.90	0.04	0.58	.56	0.05	0.76	.45
Sequencing	0.15	2.12	.03	0.35	5.02	<.01	0.19	2.91	<.01	0.17	2.36	.02	0.01	0.14	.89
Experimenting	0.18	3.19	<.01	0.21	3.50	<.01	0.17	2.88	<.01	0.11	1.77	.08	0.05	0.81	.42

Table 29
California
Student Questionnaire
Student Means
Inclination to Continue Studying Science
Percentage of Students who Responded "YES"

Item	Comparison (1995)		SS&C 1 (1996)		SS&C 2 (1997)		SS&C 3 (1998)		SS&C 4 (1999)		SS&C 5 (2000)	
	n = 279		n = 319		n = 297		n = 380		n = 244		n = 183	
	mean	s.e.	mean	s.e..	mean	s.e.	mean	s.e.	mean	s.e.	mean	s.e.
Take a science class in 10th grade	92.62	1.52	94.51	1.23	97.80	0.82	94.09	1.17	96.12	1.20	93.85	1.73
Take a science class in 11th grade	75.26	2.53	75.60	2.35	76.28	2.41	73.57	2.20	70.80	2.88	72.92	3.22
Take a science class in 12th grade	54.58	2.96	54.05	2.74	54.75	2.85	54.25	2.49	49.39	3.19	51.60	3.65
Take a science class in college	65.62	2.80	61.66	2.70	65.35	2.74	63.17	2.44	64.08	3.07	59.57	3.59

Statistical Tests

Item	1995 vs. 1996			1995 vs. 1997			1995 vs. 1998			1995 vs. 1999			1995 vs. 2000		
	Δ	z	p	Δ	z	p	Δ	z	p	Δ	z	p	Δ	z	p
Take a science class in 10th grade	1.89	0.97	.33	5.18	3.00	<.01	1.47	0.77	.44	3.50	1.81	.07	1.23	0.53	.60
Take a science class in 11th grade	0.34	0.10	.92	1.02	.29	.77	-1.69	-0.50	.62	-4.46	-1.16	.25	-2.34	-0.57	.57
Take a science class in 12th grade	-0.53	-0.13	.90	0.17	0.04	.97	-0.33	-0.09	.93	-5.19	-1.19	.23	-2.98	-0.63	.53
Take a science class in college	-3.96	-1.02	.31	-0.27	-0.07	.94	-2.45	-0.66	.51	-1.54	-0.37	.71	-6.05	-1.33	.18

Table 30
California
Student Questionnaire
Student Means
Science Motivation
Percentage of Students who Responded "YES"

Item	Comparison (1995)		SS&C 1 (1996)		SS&C 2 (1997)		SS&C 3 (1998)		SS&C 4 (1999)		SS&C 5 (2000)	
	n = 258		n = 315		n = 298		n = 386		n = 249		n = 185	
	mean	s.e.	mean	s.e.	mean	s.e.	mean	s.e.	mean	s.e.	mean	s.e.
Do you think you will pursue a career in science?	28.62	2.69	26.65	2.42	35.78	2.71	26.91	2.21	26.38	2.77	23.47	3.03
Have activities in science class made you want to take more science?	45.80	2.95	47.51	2.71	36.31	2.72	34.07	2.36	41.80	3.09	32.29	3.38
Is your science class motivating?	55.32	2.97	61.63	2.68	45.28	2.85	48.15	2.49	53.73	3.13	47.34	3.65
Have you ever had a "totally awesome" experience in your science class?	43.39	2.89	48.26	2.70	37.19	2.71	42.22	2.46	40.08	3.06	37.95	3.48

Statistical Tests

Item	1995 vs. 1996			1995 vs. 1997			1995 vs. 1998			1995 vs. 1999			1995 vs. 2000		
	Δ	z	p	Δ	z	p	Δ	z	p	Δ	z	p	Δ	z	p
Do you think you will pursue a career in science?	-1.97	-0.54	.59	7.16	1.88	.06	-1.71	-0.49	.62	-2.24	-0.58	.56	-5.15	-1.27	.20
Have activities in science class made you want to take more science?	1.71	0.43	.67	-9.49	-2.37	.02	-11.73	-3.10	<.01	-4.00	-0.94	.35	-13.51	-3.01	<.01
Is your science class motivating?	6.31	1.58	.11	-10.04	-2.44	.01	-7.17	-1.85	.06	-1.59	-0.37	.71	-7.98	-1.70	.09
Have you ever had a "totally awesome" experience in your science class?	4.87	1.23	.22	-6.20	-1.56	.12	-1.17	-0.31	.76	-3.31	-0.79	.43	-5.44	-1.20	.23

Table 31 - California
Student Questionnaire - Student Means - Students' Attitudes toward Science

Item	Comparison (1995)		SS&C 1 (1996)		SS&C 2 (1997)		SS&C 3 (1998)		SS&C 4 (1999)		SS&C 5 (2000)	
	n = 294		n = 340		n = 317		n = 401		n = 253		n = 194	
	mean	s.e.	mean	s.e.	mean	s.e.	mean	s.e.	mean	s.e.	mean	s.e.
Science is useful to me outside of class.	3.19	0.07	3.33	0.07	3.25	0.07	3.06	0.06	3.28	0.07	3.26	0.09
The things you learn in science relate to the real world.	3.77	0.07	3.72	0.07	3.79	0.06	3.67	0.06	3.76	0.07	3.99	0.07
Much of what you learn in science classes will be useful in the future.	3.73	0.07	3.78	0.06	3.65	0.06	3.72	0.05	3.84	0.07	3.83	0.07
It is important to know some science in order to get a good job.	3.67	0.06	3.69	0.05	3.72	0.05	3.69	0.05	3.73	0.06	3.72	0.06
Science class is interesting.	3.00	0.07	3.09	0.07	2.83	0.07	2.83	0.06	2.99	0.08	2.75	0.08
Science class is fun.	3.20	0.07	3.19	0.06	2.93	0.07	2.97	0.06	3.05	0.08	2.80	0.08

1 = Strongly Disagree, 2 = Disagree, 3 = No Opinion, 4 = Agree, 5 = Strongly Agree

Statistical Tests

Item	1995 vs. 1996			1995 vs. 1997			1995 vs. 1998			1995 vs. 1999			1995 vs. 2000		
	Δ	t	p	Δ	t	p	Δ	t	p	Δ	t	p	Δ	t	p
Science is useful to me outside of class.	0.14	1.50	.13	0.06	0.65	.52	-0.12	-1.31	.19	0.10	0.93	.36	0.07	0.61	.54
The things you learn in science relate to the real world.	-0.05	-0.50	.62	0.03	0.28	.78	-0.10	-1.04	.30	-0.04	-0.04	.97	0.22	2.07	.04
Much of what you learn in science classes will be useful in the future.	0.06	0.65	.52	-0.08	-0.84	.40	-0.03	-0.04	.97	0.11	1.15	.25	0.10	1.00	0.32
It is important to know some science in order to get a good job.	0.02	0.22	.83	0.04	0.55	.58	0.02	0.23	.82	0.06	0.70	.48	0.05	0.51	.61
Science class is interesting.	0.09	0.92	.36	-0.17	-1.70	.09	-0.17	-1.72	.09	-0.08	-0.08	.94	-0.25	-2.26	.02
Science class is fun.	-0.01	-0.14	.89	-0.27	2.94	<.01	-0.24	-2.56	.01	-0.15	-1.52	.13	-0.40	-3.90	<.01

Table 32
California
Student Questionnaire
Student Means
Percent of Students Who Have Participated in Science Activities Outside of Class

Activity	Comparison (1995)		SS&C 1 (1996)		SS&C 2 (1997)		SS&C 3 (1998)		SS&C 4 (1999)		SS&C 5 (2000)	
	n = 286		n = 338		n = 313		n = 404		n = 251		n = 193	
	mean	s.e.	mean	s.e.	mean	s.e.	mean	s.e.	mean	s.e.	mean	s.e.
Talk about what you learn in science class	56.81	2.86	60.00	2.64	52.22	2.80	50.36	2.46	55.86	3.11	46.70	3.56
Watch a science program on TV	62.84	2.81	63.29	2.60	61.88	2.72	57.77	2.44	55.08	3.11	44.67	3.55
Go bird watching	10.37	1.77	13.91	1.87	15.05	2.00	13.77	1.70	12.89	2.10	7.61	1.89
Go to a science museum	35.43	2.76	36.02	2.58	25.94	2.45	20.87	2.00	20.39	2.53	17.77	2.73
Talk about science topics	47.65	2.90	52.89	2.69	48.75	2.80	45.76	2.45	41.02	3.08	44.67	3.55

Statistical Tests

Activity	1995 vs. 1996			1995 vs. 1997			1995 vs. 1998			1995 vs. 1999			1995 vs. 2000		
	Δ	z	p	Δ	z	p	Δ	z	p	Δ	z	p	Δ	z	p
Talk about what you learn in science class	3.19	0.82	.41	-4.59	-1.15	.25	-6.45	-1.71	.09	-0.95	-0.22	.83	-10.11	-2.21	.03
Watch a science program on TV	0.45	0.12	.90	-0.96	-0.25	.80	-5.07	-1.36	.17	-7.76	-1.85	.06	-18.17	-4.01	<.01
Go bird watching	3.54	1.37	.17	4.68	1.75	.08	3.40	1.39	.16	2.52	0.92	.36	-2.76	-1.07	.28
Go to a science museum	0.59	0.16	.87	-9.49	-2.57	.01	-14.56	-4.27	<.01	-15.04	-4.02	<.01	-17.66	-4.55	<.01
Talk about science topics	5.24	1.32	.19	1.10	0.27	.79	-1.89	-0.50	.62	-6.63	-1.57	.12	-2.98	-0.65	.52

Table 33 – California: Student Questionnaire
Percent of Students Who Have Participated in Science Activities Outside of Class (continued)

Activity	Comparison (1995)		SS&C 1 (1996)		SS&C 2 (1997)		SS&C 3 (1998)		SS&C 4 (1999)		SS&C 5 (2000)	
	n = 286		n = 338		n = 313		n = 404		n = 251		n = 193	
	mean	s.e.	mean	s.e.	mean	s.e.	mean	s.e.	mean	s.e.	mean	s.e.
Build a telescope	7.33	1.51	6.05	1.28	4.38	1.15	7.30	1.28	5.47	1.42	3.57	1.33
Read books about science	47.65	2.90	43.64	2.67	40.44	2.75	37.53	2.39	36.22	3.02	37.76	3.47
Do a science experiment	53.18	2.89	54.47	2.68	45.62	2.79	46.23	2.46	48.44	3.13	34.52	3.40
Write an article for a science journal	9.33	1.68	35.26	2.57	16.67	2.09	16.71	1.84	8.98	1.79	5.58	1.64
Read a science magazine	42.81	2.87	48.41	2.69	36.05	2.69	35.27	2.35	37.40	3.04	30.26	3.30

Statistical Tests

Activity	1995 vs. 1996			1995 vs. 1997			1995 vs. 1998			1995 vs. 1999			1995 vs. 2000		
	Δ	z	p	Δ	z	p	Δ	z	p	Δ	z	p	Δ	z	p
Build a telescope	-1.28	-0.65	.52	-2.95	-1.55	.12	-0.03	-0.02	.98	-1.86	-0.90	.37	-3.76	-1.87	.06
Read books about science	-4.01	-1.02	.31	-7.21	-1.80	.07	-10.12	-2.69	.01	-11.43	-2.73	.01	-9.89	-2.19	.03
Do a science experiment	1.29	0.33	.74	-7.56	-1.88	.06	-6.95	-1.83	.07	-4.74	-1.11	.27	-18.66	-4.18	<.01
Write an article for a science journal	25.93	8.45	<.01	7.34	2.74	.01	7.38	2.96	<.01	-0.35	-0.14	.89	-3.75	-1.60	.11
Read a science magazine	5.60	1.42	.16	-6.76	-1.72	.09	-7.54	-2.03	.04	-5.41	-1.29	.20	-12.55	-2.87	<.01

Table 34
California
Teacher Questionnaire
Individual Means
Percent Time Spent in Individual Class Activities

Activity	**SS&C 3 (1998)**		**SS&C 4 (1999)**		**SS&C 5 (2000)**	
	n = 5		n = 5		n = 3	
	mean	s.e.	mean	s.e.	mean	s.e.
Individual Activities (Total)	11.20	3.15	13.00	2.00	18.33	4.41
Hands-on activities	30.00	13.78	58.00	7.15	18.33	18.33
Lab write-ups	13.00	5.83	13.00	3.74	5.00	2.89
Textbook seat reading	6.20	3.56	5.20	2.65	25.00	22.55
Other reading seat work	4.00	1.87	5.20	2.13	30.00	25.17
Worksheet work	6.40	3.85	5.20	3.81	8.33	6.01
Journaling	28.00	13.10	3.00	2.00	6.67	6.67
Computer work	0.00	0.00	0.40	0.40	0.00	0.00
Other	10.40	7.53	10.00	4.23	6.67	6.67

Table 35
California
Teacher Questionnaire
Individual Means
Percent Time Spent in Group Activities

Activity	SS&C 3 (1998)		SS&C 4 (1999)		SS&C 5 (2000)	
	n = 5		n = 5		n = 3	
	mean	s.e.	mean	s.e.	mean	s.e.
Group Activities (Total)	65.40	12.21	72.00	3.39	56.67	4.41
Hands-on activity	57.00	4.36	68.00	3.74	68.33	11.67
Small group discussion	21.00	10.30	7.00	2.00	16.67	6.01
Lab write-ups	24.60	6.42	10.00	1.58	8.33	1.67
Worksheet work	4.40	2.32	13.40	3.40	5.00	5.00
Other	1.00	1.00	0.60	0.60	1.67	1.67

Table 36
California
Teacher Questionnaire
Individual Means
Percent Time Spent in Whole Class Activities

Activity	SS&C 3 (1998)		SS&C 4 (1999)		SS&C 5 (2000)	
	n = 5		n = 5		n = 3	
	mean	s.e.	mean	s.e.	mean	s.e.
Whole Class Activities (Total)	11.40	3.50	15.00	1.58	25.00	7.64
Lecture	21.00	11.45	37.00	8.89	28.33	8.82
Class discussion	56.00	14.35	45.00	10.61	48.33	14.53
Demonstration	23.00	11.58	19.00	9.14	25.00	20.21

Table 37
California
Achievement Scores
Percent Correct on Achievement Tests

Test	Comparison (1995)			SS&C 1 (1996)			SS&C 2 (1997)			SS&C 3 (1998)			SS&C 4 (1999)			SS&C 5 (2000)		
	mean	s.e.	n	mean	s.e.	n	mean	s.e.	n	mean	s.e.	n	mean	s.e.	n	mean	s.e.	n
Performance Test	66.40	2.87	26	61.30	2.94	25	55.38	5.24	16	63.90	2.99	27	60.16	3.23	26	60.53	3.11	29
Science Literacy Multiple Choice	47.14	0.81	324	47.52	0.83	332	50.14	0.80	360	50.12	0.84	299	47.76	0.95	220	49.70	1.02	181
Hands-On Full Investigation	62.00	9.65	6	73.67	7.98	6	90.17	2.85	6	56.72	13.06	6	71.42	11.58	4	55.00	13.00	6
Written Full Investigation	78.11	3.48	6	31.61	15.82	6	66.11	5.19	6	28.00	20.00	2	32.00	12.90	5	49.80	18.50	5
Science Literacy Open-Ended	30.70	1.22	320	35.28	2.82	47	34.85	4.95	22	47.08	5.28	20	32.16	2.32	85	27.67	2.36	50

Statistical Tests

Test	1995 vs. 1996			1995 vs. 1997			1995 vs. 1998			1995 vs. 1999			1995 vs. 2000		
	Δ	z	p	Δ	z	p	Δ	z	p	Δ	z	p	Δ	z	p
Performance Test	-5.10	-1.24	.22	-11.02	-1.85	.06	-2.51	-0.61	.54	-6.25	-1.45	.15	-5.88	-1.39	.16
Science Literacy Multiple Choice	0.37	0.32	.75	3.00	2.69	.01	2.98	2.57	.01	0.62	0.50	.62	2.55	1.96	.05
Hands-On Full Investigation	11.67	0.93	.35	28.17	2.80	.01	-5.28	-0.33	.74	9.42	0.62	.54	-7.00	-0.43	.67
Written Full Investigation	-46.50	-2.87	<.01	-12.00	-1.92	.05	-50.11	-2.47	.01	-46.11	-3.45	<.01	-28.31	-1.50	.13
Science Literacy Open-Ended	4.58	1.49	.14	4.15	0.81	.42	16.38	3.02	<.01	1.45	0.55	.58	-3.04	-1.14	.25

Table 38
California
Lab Skills Performance Test
Student Means
Percent Correct by Total Score and Station

Station	Comparison (1995)		SS&C 1 (1996)		SS&C 2 (1997)		SS&C 3 (1998)		SS&C 4 (1999)		SS&C 5 (2000)	
	n = 26		n = 25		n = 16		n = 27		n = 26		n = 29	
	mean	s.e.	mean	s.e.	mean	s.e.	mean	s.e.	mean	s.e.	mean	s.e.
Total Score	66.40	2.87	61.30	2.94	55.38	5.24	63.90	2.99	60.16	3.23	60.53	3.11
Density	53.41	4.90	47.54	4.77	58.14	7.56	50.81	5.26	47.04	4.47	45.94	5.07
Sugar & Starch Indicators	68.63	3.99	58.11	5.12	39.58	8.13	54.08	4.88	48.33	4.88	55.91	5.13
Microscope	65.06	5.74	75.00	6.16	44.79	4.29	78.70	3.91	60.26	5.67	67.24	5.11
Rock Identification	73.18	4.83	74.11	4.33	65.28	5.73	79.01	3.35	81.73	4.09	76.53	4.43
Instruments	71.54	3.28	60.53	3.81	65.83	4.12	69.38	3.72	63.59	4.12	60.69	3.78

Statistical Tests

Station	1995 vs. 1996			1995 vs. 1997			1995 vs. 1998			1995 vs. 1999			1995 vs. 2000		
	Δ	z	p	Δ	z	p	Δ	z	p	Δ	z	p	Δ	z	p
Total Score	-5.10	-1.24	.22	-11.02	-1.85	.06	-2.51	-0.61	.54	-6.25	-1.45	.15	-5.88	-1.39	.16
Density	-5.86	-0.86	.39	4.73	0.53	.60	-2.60	-0.36	.72	-6.37	-0.96	.34	-7.46	-1.06	.29
Sugar & Starch Indicators	-10.51	-1.62	.11	-29.04	-3.21	<.01	-14.54	-2.31	.02	-20.30	-3.22	.01	-12.72	-1.96	.05
Microscope	9.94	1.18	.24	-20.27	-2.83	<.01	13.64	1.96	.05	-4.81	-0.60	.55	2.18	0.28	.78
Rock Identification	0.93	0.14	.89	-7.91	-1.05	.29	5.83	0.99	.32	8.55	1.35	.18	3.35	0.51	.61
Instruments	-11.01	-2.19	.03	-5.71	-1.08	.28	-2.16	-0.43	.67	-7.95	-1.51	.13	-10.85	-2.17	.03

Table 39
California
Science Literacy Test
Student Means
Percent Correct on Multiple Choice Items

Standard	Comparison (1995)		SS&C 1 (1996)		SS&C 2 (1997)		SS&C 3 (1998)		SS&C 4 (1999)		SS&C 5 (2000)	
	n = 324		n = 331		n = 360		n = 299		n = 220		n = 180	
	mean	s.e.	mean	s.e.	mean	s.e.	mean	s.e.	mean	s.e.	mean	s.e.
Total Score	47.12	0.81	47.52	0.83	50.14	0.77	50.12	0.83	47.76	0.95	49.70	1.02
Science as Inquiry	50.65	1.16	49.23	1.14	54.32	1.16	52.60	1.19	51.45	1.42	53.39	1.58
Physical Science	42.93	1.29	42.55	1.19	46.85	1.20	47.69	1.40	43.52	1.46	46.50	1.66
Life Science	46.63	1.02	47.83	1.17	50.95	1.02	53.09	1.15	49.17	1.32	52.81	1.40
Earth & Space Sciences	38.73	1.04	41.09	1.04	42.59	0.99	41.08	1.03	40.27	1.21	43.74	1.31
Science & Technology	48.26	0.95	48.38	0.99	48.89	0.89	48.08	0.96	49.26	1.18	47.31	1.24
Science in Personal & Social Perspectives	41.77	1.18	42.60	1.18	43.66	1.10	45.18	1.27	42.27	1.39	41.67	1.64
History & Nature of Science	60.57	0.88	60.77	0.93	62.63	0.84	61.69	0.97	58.32	1.12	61.24	1.19

Statistical Tests

Standard	1995 vs. 1996			1995 vs. 1997			1995 vs. 1998			1995 vs. 1999			1995 vs. 2000		
	Δ	z	p	Δ	z	p	Δ	z	p	Δ	z	p	Δ	z	p
Total Score	0.37	0.32	.75	3.00	2.69	.01	2.98	2.57	.01	0.62	0.50	.62	2.55	1.96	.05
Science as Inquiry	-1.41	-0.87	.38	3.67	2.24	.03	1.95	1.17	.24	0.80	0.44	.66	2.75	1.40	.16
Physical Science	-0.38	-0.22	.83	3.92	2.23	.03	4.76	2.50	.01	0.60	0.31	.76	3.57	1.70	.09
Life Science	1.20	0.77	.44	4.32	2.99	<.01	6.46	4.19	<.01	2.54	1.52	.13	6.18	3.56	<.01
Earth & Space Sciences	2.35	1.60	.11	3.86	2.69	.01	2.35	1.61	.11	1.53	0.96	.34	5.00	3.00	<.01
Science & Technology	0.12	0.09	.93	0.63	0.48	.63	-0.19	-0.14	.89	1.00	0.66	.51	-0.96	-0.61	.54
Science in Personal & Social Perspectives	0.83	0.50	.62	1.89	1.17	.24	3.41	1.97	.05	0.50	0.28	.78	-0.10	-0.05	.96
History & Nature of Science	0.21	0.16	.87	2.06	1.70	.09	1.13	0.86	.39	-2.24	-1.58	.11	0.68	0.46	.65

Table 40
California
Hands-On Full Investigation
Student Means
Percent Correct by Total Score and Subscores

	Comparison (1995)		**SS&C 1 (1996)**		**SS&C 2 (1997)**		**SS&C 3 (1998)**		**SS&C 4 (1999)**		**SS&C 5 (2000)**	
	n = 6		n = 6		n = 6		n = 6		n = 4		n = 6	
	mean	s.e.	mean	s.e.	mean	s.e.	mean	s.e.	mean	s.e.	mean	s.e.
Total Score	62.00	9.65	73.67	7.98	90.17	2.85	56.72	13.06	71.42	11.58	55.00	13.00
Number of Conditions	60.00	13.66	76.67	16.67	96.67	3.33	60.00	17.89	80.00	11.55	66.67	8.43
Access to Conditions	45.83	13.57	62.50	14.07	87.50	5.59	54.17	15.02	68.75	11.97	50.00	17.08
Amount of Conditions	70.83	13.57	87.50	5.59	83.33	5.27	50.00	15.81	75.00	25.00	41.67	19.00
Method of Measurement	66.67	10.54	75.00	17.08	100.00	0.00	58.33	15.37	75.00	14.43	50.00	12.91
Number of Bugs	66.67	8.61	66.67	8.61	83.33	7.45	61.11	10.24	58.33	8.33	66.67	17.21

Statistical Tests

	1995 vs. 1996			**1995 vs. 1997**			**1995 vs. 1998**			**1995 vs. 1999**			**1995 vs. 2000**		
	Δ	z	p	Δ	z	p	Δ	z	p	Δ	z	p	Δ	z	p
Total Score	11.67	0.93	.35	28.17	2.80	.01	-5.28	-0.33	.74	9.42	0.62	.54	-7.00	-0.43	.67
Number of Conditions	16.67	0.77	.44	36.67	2.61	.01	0.00	0.00	1.00	20.00	1.12	.26	6.67	0.42	.67
Access to Conditions	16.67	0.85	.40	41.67	2.84	<.01	8.33	0.41	.68	22.92	1.27	.20	4.17	0.19	.67
Amount of Conditions	16.67	1.14	.25	12.50	0.86	.39	-20.83	-1.00	.32	4.17	0.15	.88	-29.17	-1.25	.21
Method of Measurement	8.33	0.42	.67	33.33	3.16	<.01	-8.33	-0.45	.65	8.33	0.47	.64	-16.67	-1.00	.32
Number of Bugs	0.00	0.00	1.00	16.67	1.46	.14	-5.56	-0.42	.67	-8.34	-0.70	.48	0.00	0.00	1.00

Table 41
California
Written Full Investigation
Student Means
Percent Correct by Total Score and Subscores

	Comparison (1995)		SS&C 1 (1996)		SS&C 2 (1997)		SS&C 3 (1998)		SS&C 4 (1999)		SS&C 5 (2000)	
	n = 6		n = 6		n = 6		n = 2		n = 6		n = 5	
	mean	s.e.	mean	s.e.	mean	s.e.	mean	s.e.	mean	s.e.	mean	s.e.
Total Score	78.11	3.48	31.61	15.82	66.11	5.19	28.00	20.00	32.00	12.90	49.80	18.50
Number of Conditions	93.33	6.67	23.33	15.85	66.67	11.16	40.00	0.00	60.00	18.97	44.00	17.20
Access to Conditions	58.33	5.27	25.00	15.81	58.33	5.27	25.00	25.00	10.00	10.00	50.00	17.68
Amount of Conditions	100.00	0.00	20.83	16.35	75.00	9.13	25.00	25.00	40.00	24.49	55.00	20.00
Method of Measurement	66.67	10.54	33.33	16.67	58.33	15.37	0.00	0.00	10.00	10.00	40.00	24.49
Number of Bugs	72.22	10.24	55.56	20.49	72.22	5.56	50.00	50.00	40.00	24.49	60.00	16.33

Statistical Tests

	1995 vs. 1996			1995 vs. 1997			1995 vs. 1998			1995 vs. 1999			1995 vs. 2000		
	Δ	z	p	Δ	z	p	Δ	z	p	Δ	z	p	Δ	z	p
Total Score	-46.50	-2.87	<.01	-12.00	-1.92	.05	-50.11	-2.47	.01	-43.06	-5.21	<.01	-28.31	-1.50	.13
Number of Conditions	-70.00	-4.07	<.01	-26.67	-2.05	.04	-53.33	-8.00	<.01	-83.33	-10.38	<.01	-49.33	-2.67	.01
Access to Conditions	-33.33	-2.00	.05	0.00	0.00	1.00	-33.33	-1.30	.19	-8.33	-0.36	.72	-8.33	-0.45	.65
Amount of Conditions	-79.17	-4.84	<.01	-25.00	-2.74	.01	-75.00	-3.00	<.01	-12.50	-0.75	.45	-45.00	-2.25	.02
Method of Measurement	-33.34	-1.69	.09	-8.33	-0.45	.65	-66.67	-6.32	<.01	-66.67	-6.32	<.01	-26.67	-1.00	.32
Number of Bugs	-16.67	-0.73	.47	0.00	0.00	1.00	-22.22	-0.44	.66	-44.44	-3.81	<.01	-12.22	-0.63	.53

Table 42
Iowa
Student Questionnaire
Student Means
Percent of Time Spent by Class Activities in SS&C and Comparison Classes

Activity	Comparison (1995)		SS&C 1 (1996)		SS&C 2 (1997)		SS&C 3 (1998)		SS&C 4 (1999)		SS&C 5 (2000)	
	n = 105		n = 151		n = 140		n = 147		n = 155		n = 131	
	mean	s.e.	mean	s.e.	mean	s.e	mean	s.e	mean	s.e	mean	s.e
Inquiry	35.82	0.67	30.35	0.48	31.59	0.43	30.54	0.33	32.12	0.45	31.97	0.40
Group	25.49	0.43	37.14	0.38	35.15	0.35	34.13	0.33	34.88	0.37	33.90	0.42
Traditional	16.84	0.42	16.46	0.37	16.07	0.38	17.45	0.34	16.67	0.30	16.90	0.34
Other	21.85	0.34	16.05	0.34	17.19	0.26	17.88	0.27	16.33	0.27	17.23	0.34

Statistical Tests

Activity	1995 vs. 1996			1995 vs. 1997			1995 vs. 1998			1995 vs. 1999			1995 vs. 2000		
	Δ	z	p	Δ	z	p	Δ	z	p	Δ	z	p	Δ	z	p
Inquiry	-5.47	-6.63	<.01	-4.23	-5.32	<.01	-5.28	-7.00	<.01	-3.70	-4.56	<.01	-3.85	-4.93	<.01
Group	11.65	20.15	<.01	9.67	17.32	<.01	8.65	15.93	<.01	9.39	16.39	<.01	8.42	13.89	<.01
Traditional	-0.38	-0.68	.50	-0.76	-1.36	.17	0.61	1.14	.25	-0.17	-0.34	.73	0.06	0.11	.91
Other	-5.80	-12.09	<.01	-4.67	-10.76	<.01	-3.97	-9.07	<.01	-5.52	-12.73	<.01	-4.63	-9.53	<.01

Table 43
Iowa
Student Questionnaire
Student Means
Frequency of Class Activities in SS&C and Comparison Classes

Activity	Comparison (1995)			SS&C 1 (1996)			SS&C 2 (1997)			SS&C 3 (1998)			SS&C 4 (1999)			SS&C 5 (2000)		
	mean	s.e.	n	mean	s.e.	n	mean	s.e.	n	mean	s.e.	n	mean	s.e.	n.	mean	s.e.	
Inquiry	3.14	0.09	107	3.40	0.08	154	3.88	0.07	142	3.56	0.06	150	3.67	0.07	160	3.59	0.07	1
Group	2.19	0.05	111	4.09	0.05	153	4.29	0.05	143	3.95	0.05	150	3.98	0.06	161	3.75	0.05	1
Traditional	1.44	0.04	110	1.82	0.05	154	1.98	0.06	143	2.04	0.05	150	1.92	0.05	158	1.89	0.05	1
Other	1.87	0.04	110	1.79	0.05	154	2.09	0.04	141	2.09	0.04	150	1.86	0.04	159	1.93	0.05	1

1 = Never, 2 = Less than once a week, 3 = About once a week, 4 = Several times a week, 5 = Almost every day

Statistical Tests

Activity	1995 vs. 1996			1995 vs. 1997			1995 vs. 1998			1995 vs. 1999			1995 vs. 2000		
	Δ	t	p	Δ	t	p	Δ	t	p	Δ	t	p	Δ	t	
Inquiry	0.26	2.25	.03	0.75	6.90	<.01	0.42	4.17	<.01	0.53	4.96	<.01	0.45	4.25	<.
Group	1.90	27.84	<.01	2.10	29.07	<.01	1.76	23.42	<.01	1.79	21.67	<.01	1.56	21.81	<.
Traditional	0.38	5.81	<.01	0.54	7.19	<.01	0.60	8.77	<.01	0.47	7.25	<.01	0.45	6.69	<.
Other	-0.08	-1.37	.17	0.22	4.33	<.01	0.22	3.85	<.01	-0.01	-0.26	.79	0.06	0.91	.

Table 44
Iowa
Student Questionnaire
Student Means
Frequency of Inquiry Class Activities

Activity	Comparison (1995)		SS&C 1 (1996)		SS&C 2 (1997)		SS&C 3 (1998)		SS&C 4 (1999)		SS&C 5 (2000)	
	n = 107		n = 154		n = 142		n = 150		n = 160		n = 132	
	mean	s.e.	mean	s.e.	mean	s.e	mean	s.e	mean	s.e	mean	s.e
Total (Combined Inquiry)	3.14	0.09	3.40	0.08	3.88	0.07	3.56	0.06	3.67	0.07	3.59	0.07
Demonstration of a scientific principle	3.34	0.10	3.53	0.08	3.85	0.07	3.53	0.07	3.83	0.07	3.59	0.07
Ask students to suggest hypotheses	2.68	0.12	3.17	0.10	3.85	0.10	3.44	0.09	3.47	0.10	3.51	0.09
Ask students to interpret data	3.06	0.12	3.58	0.10	4.02	0.08	3.84	0.08	3.77	0.08	3.80	0.08
Relate previous work to current topic	3.36	0.12	3.34	0.10	3.80	0.09	3.44	0.08	3.60	0.08	3.46	0.09

1 = Never, 2 = Less than once a week, 3 = About once a week, 4 = Several times a week, 5 = Almost every day

Statistical Tests

Activity	1995 vs. 1996			1995 vs. 1997			1995 vs. 1998			1995 vs. 1999			1995 vs. 2000		
	Δ	t	p	Δ	t	p	Δ	t	p	Δ	t	p	Δ	t	p
Total (Combined Inquiry)	0.26	2.25	.03	0.75	6.90	<.01	0.42	4.17	<.01	0.53	4.96	<.01	0.45	4.25	<.01
Demonstration of a scientific principle	0.18	1.47	.14	0.51	4.23	<.01	0.19	1.62	.11	0.49	4.13	<.01	0.25	2.11	.04
Ask students to suggest hypotheses	0.49	3.11	<.01	1.17	7.69	<.01	0.76	5.03	<.01	0.78	5.01	<.01	0.83	5.60	<.01
Ask students to interpret data	0.52	3.44	<.01	0.96	6.81	<.01	0.78	5.78	<.01	0.71	5.24	<.01	0.75	5.25	<.01
Relate previous work to current topic	-0.03	-0.19	.85	0.44	3.03	<.01	0.08	0.57	.57	0.24	1.70	.09	0.10	0.67	.51

Table 45
Iowa
Student Questionnaire
Student Means
Frequency of Group Class Activities

Activity	Comparison (1995)		SS&C 1 (1996)		SS&C 2 (1997)		SS&C 3 (1998)		SS&C 4 (1999)		SS&C 5 (2000)	
	n = 111		n= 153		n = 143		n = 150		n = 161		n = 134	
	mean	s.e.	mean	s.e.	mean	s.e	mean	s.e	mean	s.e	mean	s.e
Total (Combined Group)	2.19	0.05	4.09	0.05	4.29	0.05	3.95	0.05	3.98	0.06	3.75	0.05
Do experiments with other students	2.04	0.04	4.12	0.06	4.31	0.07	3.96	0.07	4.03	0.07	3.83	0.07
Work in groups	2.26	0.06	4.50	0.05	4.58	0.05	4.11	0.06	4.21	0.07	4.04	0.07
Share results from experiments	2.28	0.08	3.62	0.08	3.98	0.09	3.78	0.08	3.71	0.08	3.39	0.08

1 = Never, 2 = Less than once a week, 3 = About once a week, 4 = Several times a week, 5 = Almost every day

Statistical Tests

Activity	1995 vs. 1996			1995 vs. 1997			1995 vs. 1998			1995 vs. 1999			1995 vs. 2000		
	Δ	t	p	Δ	t	p	Δ	t	p	Δ	t	p	Δ	t	p
Total (Combined Group)	1.90	27.84	<.01	2.10	29.07	<.01	1.76	23.42	<.01	1.79	21.67	<.01	1.56	21.81	<.01
Do experiments with other students	2.09	25.48	<.01	2.27	25.78	<.01	1.92	21.00	<.01	2.00	22.56	<.01	1.79	20.86	<.01
Work in groups	2.24	28.60	<.01	2.32	31.71	<.01	1.85	20.44	<.01	1.95	19.13	<.01	1.78	19.74	<.01
Share results from experiments	1.34	11.67	<.01	1.70	14.28	<.01	1.48	13.02	<.01	1.43	12.14	<.01	1.11	9.72	<.01

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Table 46
Iowa
Student Questionnaire
Student Means
Frequency of Traditional Class Activities

Activity	Comparison (1995)		SS&C 1 (1996)		SS&C 2 (1997)		SS&C 3 (1998)		SS&C 4 (1999)		SS&C 5 (2000)	
	n = 110		n = 154		n = 143		n = 150		n = 158		n = 134	
	mean	s.e.	mean	s.e	mean	s.e	mean	s.e	mean	s.e	mean	s.e
Total (Combined Traditional)	1.44	0.04	1.82	0.05	1.98	0.06	2.04	0.05	1.92	0.05	1.89	0.05
Read articles on science	1.59	0.08	2.03	0.06	2.06	0.08	2.47	0.07	2.19	0.06	1.90	0.07
Do oral or written reports	1.16	0.04	1.31	0.05	2.10	0.10	1.56	0.06	1.69	0.07	1.79	0.07
Read other science materials	1.58	0.08	2.13	0.10	1.79	0.08	2.09	0.08	1.86	0.08	1.99	0.08

1 = Never, 2 = Less than once a week, 3 = About once a week, 4 = Several times a week, 5 = Almost every day

Statistical Tests

Activity	1995 vs. 1996			1995 vs. 1997			1995 vs. 1998			1995 vs. 1999			1995 vs. 2000		
	Δ	t	p	Δ	t	p	Δ	t	p	Δ	t	p	Δ	t	p
Total (Combined Traditional)	0.38	5.81	<.01	0.54	7.19	<.01	0.60	8.77	<.01	0.47	7.25	<.01	0.45	6.69	<.01
Read articles on science	0.43	4.23	<.01	0.47	4.14	<.01	0.88	8.41	<.01	0.60	6.08	<.01	0.31	2.96	<.01
Do oral or written reports	0.15	2.21	.03	0.94	8.03	<.01	0.39	5.02	<.01	0.53	6.12	<.01	0.63	7.87	<.01
Read other science materials	0.55	4.26	<.01	0.21	1.95	.05	0.52	4.38	<.01	0.28	2.51	.01	0.42	3.82	<.01

Table 47
Iowa
Student Questionnaire
Student Means
Frequency of Other Class Activities

Activity	Comparison (1995)		SS&C 1 (1996)		SS&C 2 (1997)		SS&C 3 (1998)		SS&C 4 (1999)		SS&C 5 (2000)	
	n = 110		n = 154		n = 141		n = 150		n = 159		n = 135	
	mean	s.e.	mean	s.e	mean	s.e	mean	s.e	mean	s.e	mean	s.e
Total (Combined Other)	1.87	0.04	1.79	0.05	2.09	0.04	2.09	0.04	1.86	0.04	1.93	0.05
Watch films, slides, or videos	2.15	0.05	1.81	0.05	2.30	0.05	2.57	0.05	2.21	0.04	2.24	0.06
Go outside for class instruction	1.59	0.05	1.77	0.06	1.89	0.05	1.62	0.06	1.50	0.05	1.62	0.06

1 = Never, 2 = Less than once a week, 3 = About once a week, 4 = Several times a week, 5 = Almost every day

Statistical Tests

Activity	1995 vs. 1996			1995 vs. 1997			1995 vs. 1998			1995 vs. 1999			1995 vs. 2000		
	Δ	t	p	Δ	t	p	Δ	t	p	Δ	t	p	Δ	t	p
Total (Combined Other)	-0.08	-1.37	.17	0.22	4.33	<.01	0.22	3.85	<.01	-0.01	-0.26	.79	0.06	0.91	.36
Watch films, slides, or videos	-0.35	-4.71	<.01	0.14	2.07	.04	0.41	5.46	<.01	0.06	0.86	.39	0.08	1.09	.28
Go outside for class instruction	0.18	2.18	.03	0.29	4.31	<.01	0.02	0.27	.78	-0.09	-1.35	.18	0.03	0.34	.73

Table 48
Iowa
Teacher Questionnaire
Individual Means
Frequency of Class Activities

Activity	Comparison (1995)		SS&C 1 (1996)		SS&C 2 (1997)	SS&C 3 (1998)		SS&C 4 (1999)		SS&C 5 (2000)	
	n = 2		n = 3		No data for 1997.	n = 1		n = 3		n = 2	
	mean	s.e.	mean	s.e.		mean	s.e.	mean	s.e.	mean	s.e.
Inquiry	3.00	0.75	4.33	0.22		3.58	0.08	4.42	0.30	4.50	0.25
Traditional	2.17	0.17	2.67	0.00		2.33	0.00	2.33	0.19	2.33	0.33

1 = Never, 2 = Less than once a week, 3 = About once a week, 4 = Several times a week, 5 = Almost every day

Statistical Tests

Activity	1995 vs. 1996			1995 vs. 1997	1995 vs. 1998			1995 vs. 1999			1995 vs. 2000		
	Δ	t	p	No data for 1997	Δ	t	p	Δ	t	p	Δ	t	p
Inquiry	1.33	2.13	.12		0.58	0.77	.52	1.42	2.08	.13	1.50	1.90	.20
Traditional	0.50	4.03	.03		0.17	1.00	.42	0.17	0.60	.59	0.17	0.45	.70

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Table 49
Iowa
Teacher Questionnaire
Individual Means
Frequency of Inquiry Class Activities

Activity	Comparison (1995)		SS&C 1 (1996)		SS&C 2 (1997)	SS&C 3 (1998)		SS&C 4 (1999)		SS&C 5 (2000)	
	n = 2		n = 3		No data for 1997	n = 1		n = 3		n = 2	
	mean	s.e.	mean	s.e.		mean	s.e.	mean	s.e.	mean	s.e.
Total (Combined Inquiry)	3.00	0.75	4.33	0.22		3.58	0.08	4.42	0.30	4.50	0.25
Do experiments	2.50	0.50	4.67	0.33		4.00	0.00	4.50	0.50	4.00	0.00
Ask for reasons for the results of experiments	3.50	0.50	4.00	0.00		3.00	0.00	4.33	0.33	4.50	0.50
Ask students to suggest hypotheses	3.00	1.00	4.33	0.33		3.00	0.00	4.33	0.33	4.50	0.50
Ask students to interpret data	3.00	1.00	4.33	0.33		4.00	0.00	4.67	0.33	5.00	0.00

1 = Never, 2 = Less than once a week, 3 = About once a week, 4 = Several times a week, 5 = Almost every day

Statistical Tests

Activity	1995 vs. 1996			1995 vs. 1997	1995 vs. 1998			1995 vs. 1999			1995 vs. 2000		
	Δ	t	p	No data for 1997	Δ	t	p	Δ	t	p	Δ	t	p
Total (Combined Inquiry)	1.33	2.13	.12		0.58	0.77	.52	1.42	2.08	.13	1.50	1.90	.20
Do experiments	2.17	3.81	.03		1.50	3.00	.10	2.00	2.83	.11	1.50	3.00	.10
Ask for reasons for the results of experiments	0.50	1.34	.27		-0.50	-0.58	.67	0.83	1.46	.24	1.00	1.41	.29
Ask students to suggest hypotheses	1.33	1.55	.22		0.00	0.00	1.00	1.33	1.55	.22	1.50	1.34	.31
Ask students to interpret data	1.33	1.55	.22		1.00	1.00	.42	1.67	1.94	.15	2.00	2.00	.18

Table 50
Iowa
Teacher Questionnaire
Individual Means
Frequency of Traditional Class Activities

Activity	Comparison (1995)		SS&C 1 (1996)		SS&C 2 (1997)	SS&C 3 (1998)		SS&C 4 (1999)		SS&C 5 (2000)	
	n = 2		n = 3		No data for 1997	n = 2		n = 3		n = 2	
	mean	s.e.	mean	s.e.		mean	s.e.	mean	s.e.	mean	s.e.
Total (Combined Traditional)	2.17	0.17	2.67	0.00		2.33	0.00	2.33	0.19	2.33	0.33
Read articles on science	2.00	0.00	3.00	0.00		2.00	0.00	2.33	0.33	2.00	0.00
Do oral or written reports	2.00	0.00	2.33	0.33		3.00	0.00	2.33	0.33	2.50	0.50
Read other science materials	2.50	0.50	2.67	0.33		2.00	0.00	2.33	0.33	2.50	0.50

1 = Never, 2 = Less than once a week, 3 = About once a week, 4 = Several times a week, 5 = Almost every day

Statistical Tests

Activity	1995 vs. 1996			1995 vs. 1997	1995 vs. 1998			1995 vs. 1999			1995 vs. 2000		
	Δ	t	p	No data for 1997	Δ	t	p	Δ	t	p	Δ	t	p
Total (Combined Traditional)	0.50	4.03	.03		0.17	1.00	.42	0.17	0.60	.59	0.17	0.45	.70
Read articles on science	*Can't be calculated				*Can't be calculated			0.33	0.78	.50	*Can't be calculated		
Do oral or written reports	0.33	0.78	.50		*Can't be calculated			0.33	0.78	.50	0.50	1.00	.42
Read other science materials	0.17	0.29	.79		-0.50	-1.00	.42	-0.17	-0.29	.79	0.00	0.00	1.00

* The t-test cannot be calculated because the standard error for both terms is zero.

Table 51
Iowa
Classroom Observations
Percent Time Spent by Teaching Style

Style	Comparison (1995)		SS&C 1 (1996)		SS&C 2 (1997)		SS&C 3 (1998)		SS&C 4 (1999)		SS&C 5 (2000)	
	n = 6		n = 7		n = 2		n = 3		n = 5		n = 2	
	freq.	%	freq.	%	freq.	%	freq.	%	freq.	%	freq.	%
Teacher-Centered	5	9.26	8	12.50	2	11.11	9	34.62	0	0.00	0	0.00
Student- & Teacher-Centered	34	62.96	12	18.75	6	33.33	3	11.54	19	42.22	2	10.53
Student-Centered	1	1.85	24	37.50	7	38.89	10	38.46	18	40.00	12	63.16
Administrative	6	11.11	8	12.50	2	11.11	3	11.54	5	11.11	5	26.32
Other activities	8	14.81	12	18.75	1	5.56	1	3.85	3	6.67	0	0.00

Statistical Tests

Style	1995 vs. 1996		1995 vs. 1997		1995 vs. 1998		1995 vs. 1999		1995 vs. 2000	
	χ^2	p	χ^2	p	χ^2	p	χ^2	p	χ^2	p
Teacher-Centered										
Student- & Teacher-Centered										
Student-Centered										
Administrative										
Other activities										
	32.44	<.01	18.36	<.01	39.72	<.01	26.48	<.01	44.01	<.01

χ^2 critical values: At .05 = 9.49; at .025 = 11.14; at .01 = 13.28

Table 52
Iowa
Classroom Observations
Frequency of Student Involvement and Type of Instruction

Variable *Response*	Comparison (1995)		SS&C 1 (1996)		SS&C 2 (1997)		SS&C 3 (1998)		SS&C 4 (1999)		SS&C 5 (2000)	
	n = 6		n = 7		n = 2		n = 2		n = 5		n = 2	
	freq.	%	freq.	%	freq.	%	freq.	%	freq.	%	freq.	%
Student Involvement												
Almost always	2	33.3	4	57.1	2	100.0	2	100.0	3	60.0	2	100.0
Sometimes	4	66.7	2	28.6	0	0.0	0	0.0	2	40.0	0	0.0
Almost never	0	0.0	1	14.3	0	0.0	0	0.0	0	0.0	0	0.0
Type of Instruction												
Traditional	4	66.7	2	33.3	0	0.0	0	0.0	4	80.0	0	0.0
Mixed	2	33.3	3	50.0	2	100.0	2	100.0	1	20.0	2	100.0
Inquiry	0	0.0	1	16.7	0	0.0	0	0.0	0	0.0	0	0.0

Statistical Tests

Variable	1995 vs. 1996		1995 vs. 1997		1995 vs. 1998		1995 vs. 1999		1995 vs. 2000	
	χ^2	p	χ^2	p	χ^2	p	χ^2	p	χ^2	p
Student Involvement	2.27	.32	2.67	.10	2.67	.10	0.78	.38	2.67	.10
Type of Instruction	1.87	.39	2.67	.10	2.67	.10	0.24	.62	2.67	.10

Table 53
Iowa
Curriculum Verification
Number of Weeks Spent on Science Topics

Standard	Comparison (1995)		SS&C 1 (1996)		SS&C 2 (1997)		SS&C 3 (1998)		SS&C 4 (1999)		SS&C 5 (2000)	
	classes affected = 8		classes affected = 10		classes affected = 10		classes affected = 10		classes affected = 10		classes affected = 9	
	weeks	%	weeks	%	weeks	%	weeks	%	weeks	%	weeks	%
Chemistry	2.0	2.86	4.0	10.53	10.0	29.41	11.3	31.30	10.5	28.57	11.0	30.56
Biology	30.0	42.86	12.0	31.589	7.5	22.06	10.0	27.70	14.0	38.10	7.0	19.44
Earth & Space Sciences	36.0	51.43	0.0	0.00	7.5	22.06	3.3	9.14	2.3	6.12	10.0	27.78
Physics	2.0	2.86	22.0	57.89	9.0	26.47	9.5	26.32	10.0	27.21	8.0	22.22
Measurement	0.0	0.00	0.0	0.00	0.0	0.00	2.0	5.54	0.0	0.00	0.0	0.00
Science & Society	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00
Miscellaneous	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00

Table 54
Iowa
Learning Environment Inventory
Student Means

Subscale	Comparison (1995)		SS&C 1 (1996)		SS&C 2 (1997)		SS&C 3 (1998)		SS&C 4 (1999)		SS&C 5 (2000)	
	n = 111		n = 155		n = 143		n = 151		n = 161		n = 135	
	mean	s.e.	mean	s.e.	mean	s.e.	mean	s.e.	mean	s.e.	mean	s.e.
Difficulty	3.09	0.08	2.92	0.07	2.90	0.06	2.67	0.06	2.82	0.06	3.13	0.06
Relevance	3.35	0.06	3.29	0.06	3.82	0.06	3.69	0.05	3.69	0.06	3.69	0.06
Critical Voice	3.16	0.08	3.18	0.09	3.83	0.06	3.54	0.06	3.64	0.06	3.60	0.06
Involvement	3.69	0.06	3.54	0.06	4.00	0.06	3.85	0.05	3.89	0.05	3.82	0.05
Sequencing	2.61	0.07	2.91	0.06	2.76	0.06	2.66	0.06	2.77	0.06	2.54	0.06
Experimenting	2.11	0.06	2.34	0.05	2.76	0.06	2.60	0.06	2.64	0.05	2.73	0.06

1 = Almost Never, 2 = Seldom, 3 = Sometimes, 4 = Often, 5 = Almost Always

Statistical Tests

Subscale	1995 vs. 1996			1995 vs. 1997			1995 vs. 1998			1995 vs. 1999			1995 vs. 2000		
	Δ	t	p	Δ	t	p	Δ	t	p	Δ	t	p	Δ	t	p
Difficulty	-0.16	-1.45	.15	-0.18	-1.88	.06	-0.41	-4.10	<.01	-0.27	-2.66	.01	0.04	0.46	.65
Relevance	-0.05	-0.59	.56	0.48	5.46	<.01	0.34	4.07	<.01	0.35	4.01	<.01	0.35	3.93	<.01
Critical Voice	0.03	0.22	.82	0.67	6.71	<.01	0.38	3.93	<.01	0.48	5.05	<.01	0.45	4.45	<.01
Involvement	-0.14	-1.64	.10	0.32	3.76	<.01	0.16	1.97	.05	0.20	2.55	.01	0.14	1.71	.09
Sequencing	0.30	3.13	<.01	0.15	1.55	.12	0.05	0.54	.59	0.16	1.64	.10	-0.07	-0.74	.46
Experimenting	0.23	2.84	<.01	0.65	7.83	<.01	0.50	6.00	<.01	0.53	6.55	<.01	0.63	7.64	<.01

Table 55
Iowa
Student Questionnaire
Student Means
Inclination to Continue Studying Science
Percentage of Students who Responded "YES"

Item	Comparison (1995)		SS&C 1 (1996)		SS&C 2 (1997)		SS&C 3 (1998)		SS&C 4 (1999)		SS&C 5 (2000)	
	n = 106		n = 147		n = 138		n = 143		n = 157		n = 128	
	mean	s.e.	mean	s.e..	mean	s.e.	mean	s.e.	mean	s.e.	mean	s.e.
Take a science class in 10th grade	98.20	1.27	99.35	0.65	100.00	0.00	99.34	0.66	98.76	0.88	100.00	0.00
Take a science class in 11th grade	83.49	3.57	85.06	2.88	90.14	2.51	91.33	2.30	92.55	2.08	96.30	1.63
Take a science class in 12th grade	38.68	4.75	54.97	4.06	65.71	4.03	68.71	3.84	66.87	3.73	71.43	3.93
Take a science class in college	65.74	4.59	55.26	4.05	67.39	4.01	74.15	3.62	60.51	3.91	64.64	4.21

Statistical Tests

Item	1995 vs. 1996			1995 vs. 1997			1995 vs. 1998			1995 vs. 1999			1995 vs. 2000		
	Δ	z	p	Δ	z	p	Δ	z	p	Δ	z	p	Δ	z	p
Take a science class in 10th grade	1.15	0.81	.42	1.80	1.42	.16	1.14	0.80	.42	0.56	0.36	.72	1.80	1.42	.16
Take a science class in 11th grade	1.57	0.34	.73	6.65	1.52	.13	7.84	1.85	.06	9.06	2.19	.03	12.81	3.26	<.01
Take a science class in 12th grade	16.29	2.61	.01	27.04	4.34	<.01	30.03	4.92	<.01	28.19	4.67	<.01	32.75	5.31	<.01
Take a science class in college	-10.48	-1.71	.09	1.65	0.27	.79	8.41	1.44	.15	-5.23	-0.87	.38	-1.12	-0.18	.86

Table 56
Iowa
Student Questionnaire
Student Means
Science Motivation
Percentage of Students who Responded "YES"

Item	Comparison (1995)		SS&C 1 (1996)		SS&C 2 (1997)		SS&C 3 (1998)		SS&C 4 (1999)		SS&C 5 (2000)	
	n = 108		n = 148		n = 143		n = 147		n = 158		n = 130	
	mean	s.e.	mean	s.e.	mean	s.e.	mean	s.e.	mean	s.e.	mean	s.e.
Do you think you will pursue a career in science?	26.13	4.19	21.05	3.32	37.06	4.05	36.05	3.97	29.38	3.61	34.07	4.09
Have activities in science class made you want to take more science?	33.64	4.53	32.24	3.80	74.13	3.68	68.87	3.78	70.62	3.61	62.60	4.24
Is your science class motivating?	39.09	4.67	38.31	3.93	86.01	2.91	80.67	3.24	80.00	3.17	83.33	3.26
Have you ever had a "totally awesome" experience in your science class?	29.09	4.35	40.65	3.96	86.71	2.85	80.79	3.22	80.00	3.17	72.59	3.85

Statistical Tests

Item	1995 vs. 1996			1995 vs. 1997			1995 vs. 1998			1995 vs. 1999			1995 vs. 2000		
	Δ	z	p	Δ	z	p	Δ	z	p	Δ	z	p	Δ	z	p
Do you think you will pursue a career in science?	-5.08	-0.95	.34	10.93	1.88	.06	9.92	1.72	.09	3.25	0.59	.56	7.94	1.36	.17
Have activities in science class made you want to take more science?	-1.40	-0.24	.81	40.49	6.94	<.01	35.23	5.97	<.01	36.98	6.38	<.01	28.96	4.67	<.01
Is your science class motivating?	-0.78	-0.13	.90	46.92	8.53	<.01	41.58	7.32	<.01	40.91	7.25	<.01	44.24	7.77	<.01
Have you ever had a "totally awesome" experience in your science class?	11.56	1.97	.05	57.62	11.08	<.01	51.70	9.55	<.01	50.91	9.46	<.01	43.50	7.49	<.01

Table 57 - Iowa
Student Questionnaire - Student Means - Students' Attitudes toward Science

Item	Comparison (1995)		SS&C 1 (1996)		SS&C 2 (1997)		SS&C 3 (1998)		SS&C 4 (1999)		SS&C 5 (2000)	
	n = 109		n = 155		n = 143		n = 151		n = 160		n = 134	
	mean	s.e.	mean	s.e.	mean	s.e.	mean	s.e.	mean	s.e.	mean	s.e.
Science is useful to me outside of class.	3.28	0.11	3.32	0.10	3.82	0.09	3.65	0.09	3.71	0.08	3.70	0.09
The things you learn in science relate to the real world.	3.84	0.11	3.77	0.08	4.38	0.06	4.06	0.08	4.06	0.08	4.11	0.07
Much of what you learn in science classes will be useful in the future.	3.57	0.10	3.47	0.09	3.90	0.08	3.88	0.08	3.80	0.08	3.70	0.09
It is important to know some science in order to get a good job.	3.75	0.09	3.65	0.08	3.90	0.08	3.97	0.06	3.89	0.06	3.80	0.08
Science class is interesting.	2.73	0.12	2.59	0.09	3.97	0.08	3.73	0.08	3.81	0.08	3.63	0.08
Science class is fun.	2.78	0.11	2.81	0.09	4.01	0.08	3.80	0.07	3.82	0.08	3.77	0.08

1 = Strongly Disagree, 2 = Disagree, 3 = No Opinion, 4 = Agree, 5 = Strongly Agree

Statistical Tests

Item	1995 vs. 1996			1995 vs. 1997			1995 vs. 1998			1995 vs. 1999			1995 vs. 2000		
	Δ	t	p	Δ	t	p	Δ	t	p	Δ	t	p	Δ	t	p
Science is useful to me outside of class.	0.03	0.23	.82	0.54	3.81	<.01	0.37	2.56	.01	0.43	3.12	<.01	0.41	3.00	<.01
The things you learn in science relate to the real world.	-0.06	-0.47	.64	0.55	4.74	<.01	0.22	1.69	.09	0.23	1.76	.08	0.27	2.23	.03
Much of what you learn in science classes will be useful in the future.	-0.10	-0.75	.45	0.32	2.47	.01	0.31	2.46	.02	0.23	1.80	.07	0.12	0.94	.35
It is important to know some science in order to get a good job.	-0.10	-0.85	.40	0.14	1.18	.24	0.21	2.04	.04	0.14	1.28	.20	0.05	0.40	.69
Science class is interesting.	-0.13	-0.92	.36	1.24	8.98	<.01	1.00	7.24	<.01	1.08	7.78	<.01	0.90	6.39	<.01
Science class is fun.	0.03	0.18	.86	1.23	9.35	<.01	1.02	8.11	<.01	1.04	7.94	<.01	0.99	7.51	<.01

Table 58
Iowa
Student Questionnaire
Student Means
Percent of Students Who Have Participated in Science Activities Outside of Class

Activity	Comparison (1995)		SS&C 1 (1996)		SS&C 2 (1997)		SS&C 3 (1998)		SS&C 4 (1999)		SS&C 5 (2000)	
	n = 109		n = 154		n = 143		n = 151		n = 160		n = 134	
	mean	s.e.	mean	s.e.	mean	s.e.	mean	s.e.	mean	s.e.	mean	s.e.
Talk about what you learn in science class	54.95	4.74	46.75	4.03	68.53	3.90	66.23	3.86	67.70	3.70	71.11	3.92
Watch a science program on TV	54.95	4.74	56.77	3.99	58.04	4.14	60.26	4.00	68.32	3.68	[illegible]	4.17
Go bird watching	18.92	3.73	12.90	2.70	11.19	2.65	16.56	3.03	18.12	3.06	10.37	2.63
Go to a science museum	50.91	4.79	50.32	4.03	42.66	4.15	43.05	4.04	47.20	3.95	48.15	4.32
Talk about science topics	34.23	4.52	40.65	3.96	55.24	4.17	57.62	4.03	59.63	3.88	61.94	4.21

Statistical Tests

Activity	1995 vs. 1996			1995 vs. 1997			1995 vs. 1998			1995 vs. 1999			1995 vs. 2000		
	Δ	z	p	Δ	z	p	Δ	z	p	Δ	z	p	Δ	z	p
Talk about what you learn in science class	-8.20	-1.32	.19	13.58	2.21	.03	11.28	1.85	.06	12.75	2.12	.03	16.16	2.63	.01
Watch a science program on TV	1.82	0.29	.77	3.09	0.49	.62	5.31	0.86	.39	13.37	2.23	.03	8.01	1.27	.20
Go bird watching	-6.02	-1.31	.19	-7.73	-1.69	.09	-2.36	-0.49	.62	-0.80	-0.17	.87	-8.55	-1.87	.06
Go to a science museum	-0.59	-0.09	.93	-8.25	-1.30	.19	-7.86	-1.25	.21	-3.71	-0.60	.55	-2.76	-0.43	.67
Talk about science topics	6.42	1.07	.28	21.01	3.42	<.01	23.39	3.86	<.01	25.40	4.26	<.01	27.71	4.49	<.01

Table 59 – Iowa: Student Questionnaire
Percent of Students Who Have Participated in Science Activities Outside of Class (continued)

Activity	**Comparison (1995)**		**SS&C 1 (1996)**		**SS&C 2 (1997)**		**SS&C 3 (1998)**		**SS&C 4 (1999)**		**SS&C 5 (2000)**	
	n = 109		n = 154		n = 143		n = 151		n = 160		n = 134	
	mean	s.e.	mean	s.e.	mean	s.e.	mean	s.e.	mean	s.e.	mean	s.e.
Build a telescope	1.80	1.27	3.23	1.42	2.80	1.38	2.65	1.31	2.48	1.23	2.22	1.27
Read books about science	19.09	3.76	17.42	3.06	27.97	3.77	23.18	3.45	28.57	3.57	27.41	3.85
Do a science experiment	33.33	4.49	43.23	3.99	39.86	4.11	32.45	3.82	39.75	3.87	34.81	4.12
Write an article for a science journal	0.00	0.00	5.16	1.78	1.40	0.99	1.99	1.14	3.11	1.37	0.74	0.74
Read a science magazine	35.14	4.55	29.68	3.68	27.27	3.74	28.48	3.68	39.13	3.86	31.11	4.00

Statistical Tests

Activity	**1995 vs. 1996**			**1995 vs. 1997**			**1995 vs. 1998**			**1995 vs. 1999**			**1995 vs. 2000**		
	Δ	z	p	Δ	z	p	Δ	z	p	Δ	z	p	Δ	z	p
Build a telescope	1.43	0.75	.45	1.00	0.53	.60	0.85	0.47	.64	0.68	0.38	.70	0.42	0.23	.82
Read books about science	-1.67	-0.34	.73	8.88	1.67	.10	4.09	0.80	.42	9.48	1.83	.07	8.32	1.55	.12
Do a science experiment	9.90	1.65	.10	6.53	1.07	.28	-0.88	-0.15	.88	6.42	1.08	.28	1.48	0.24	.81
Write an article for a science journal	5.16	2.90	<.01	1.40	1.41	.16	1.99	1.75	.08	3.11	2.27	.02	0.74	1.00	.32
Read a science magazine	-5.46	-0.93	.35	-7.87	-1.34	.18	-6.66	-1.14	.25	3.99	0.67	.50	-4.03	-0.67	.50

Table 60
Iowa
Teacher Questionnaire
Individual Means
Percent Time Spent in Individual Class Activities

Activity	SS&C 3 (1998)		SS&C 4 (1999)		SS&C 5 (2000)	
	n = 2		n = 3		n = 2	
	mean	s.e.	mean	s.e.	mean	s.e.
Individual Activities (Total)	10.00	0.00	30.00	10.41	17.50	12.50
Hands-on activities	27.50	22.50	45.00	21.79	65.00	30.00
Lab write-ups	40.00	10.00	11.67	4.41	7.50	2.50
Textbook seat reading	10.00	10.00	5.00	2.89	5.00	5.00
Other reading seat work	10.00	0.00	6.67	3.33	2.50	2.50
Worksheet work	7.50	2.50	8.33	1.67	5.00	5.00
Journaling	2.50	2.50	6.67	6.67	10.00	10.00
Computer work	2.50	2.50	16.67	8.82	5.00	5.00
Other	0.00	0.00	0.00	0.00	0.00	0.00

Table 61
Iowa
Teacher Questionnaire
Individual Means
Percent Time Spent in Group Activities

Activity	SS&C 3 (1998)		SS&C 4 (1999)		SS&C 5 (2000)	
	n = 2		n = 3		n = 2	
	mean	s.e.	mean	s.e.	mean	s.e.
Group Activities (Total)	55.00	5.00	36.67	11.67	50.00	0.00
Hands-on activity	77.50	2.50	51.67	15.90	87.50	12.50
Small group discussion	10.00	0.00	25.00	13.23	2.50	2.50
Lab write-ups	7.50	2.50	16.67	16.67	5.00	5.00
Worksheet work	5.00	5.00	3.33	3.33	5.00	5.00
Other	0.00	0.00	3.33	3.33	0.00	0.00

Table 62
Iowa
Teacher Questionnaire
Individual Means
Percent Time Spent in Whole Class Activities

Activity	SS&C 3 (1998)		SS&C 4 (1999)		SS&C 5 (2000)	
	n = 2		n = 3		n = 2	
	mean	s.e.	mean	s.e.	mean	s.e.
Whole Class Activities (Total)	35.00	5.00	33.33	8.33	32.50	12.50
Lecture	22.50	2.50	40.00	10.00	35.00	5.00
Class discussion	42.50	17.50	41.67	10.14	45.00	5.00
Demonstration	35.00	15.00	18.33	4.41	20.00	0.00

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Table 63
Iowa
Achievement Scores
Percent Correct on Achievement Tests

Test	Comparison (1995)			SS&C 1 (1996)			SS&C 2 (1997)			SS&C 3 (1998)			SS&C 4 (1999)			SS&C 5 (2000)		
	mean	s.e.	n	mean	s.e.	n	mean	s.e.	n	mean	s.e.	n	mean	s.e.	n	mean	s.e.	n
Performance Test	70.05	2.20	29	74.37	2.23	27	72.49	2.98	26	75.92	2.45	30	76.62	3.00	30	81.11	1.43	30
Science Literacy Multiple Choice	67.32	0.83	194	59.88	1.04	189	62.78	0.85	185	61.96	0.78	173	60.50	0.86	187	60.22	0.98	161
Hands-On Full Investigation	67.78	12.13	6	68.44	7.35	6	80.33	6.24	6	85.44	5.05	6	68.00	8.66	6	86.56	5.66	6
Written Full Investigation	75.00	19.36	5	80.27	5.82	5	70.72	7.48	6	88.33	4.86	5	81.56	4.27	6	70.83	6.79	6
Science Literacy Open-Ended	54.25	1.55	151	44.34	2.68	53	56.32	3.83	29	52.02	2.95	33	48.52	2.43	62	47.62	2.50	63

Statistical Tests

Test	1995 vs. 1996			1995 vs. 1997			1995 vs. 1998			1995 vs. 1999			1995 vs. 2000		
	Δ	z	p	Δ	z	p	Δ	z	p	Δ	z	p	Δ	z	p
Performance Test	4.32	1.38	.17	2.44	0.66	.51	5.86	1.78	.08	6.56	1.77	.08	11.06	4.21	<.01
Science Literacy Multiple Choice	-7.44	-5.56	<.01	-4.54	-3.82	<.01	-5.36	-4.70	<.01	-6.82	-5.70	<.01	-7.10	-5.52	<.01
Hands-On Full Investigation	0.67	0.05	.96	12.56	0.92	.36	17.67	1.34	.18	0.22	0.01	.99	18.78	1.40	.16
Written Full Investigation	5.27	0.26	.79	-4.28	-0.21	.83	13.33	0.67	.50	6.56	0.33	.74	-4.17	-0.20	.84
Science Literacy Open-Ended	-9.91	-3.20	<.01	2.07	0.50	.62	-2.23	-0.67	.50	-5.73	-1.96	.05	-6.63	-2.26	.02

Table 64
Iowa
Lab Skills Performance Test
Student Means
Percent Correct by Total Score and Station

Station	Comparison (1995)		SS&C 1 (1996)		SS&C 2 (1997)		SS&C 3 (1998)		SS&C 4 (1999)		SS&C 5 (2000)	
	n = 29		n = 27		n = 26		n = 30		n = 30		n = 30	
	mean	s.e.	mean	s.e.	mean	s.e.	mean	s.e.	mean	s.e.	mean	s.e.
Total Score	70.05	2.20	74.37	2.23	72.49	2.98	75.92	2.45	76.62	3.00	81.11	1.43
Density	66.31	3.86	74.88	3.87	73.12	3.80	69.17	4.00	69.31	4.58	75.38	3.16
Sugar & Starch Indicators	62.55	5.36	66.29	4.59	67.56	5.60	73.92	4.04	72.35	5.21	81.17	2.70
Microscope	78.16	4.31	87.65	3.60	89.10	3.16	94.44	2.01	93.61	3.26	86.67	3.33
Rock Identification	80.84	2.95	82.10	3.58	68.16	4.64	85.19	3.92	85.19	3.94	90.09	2.81
Instruments	66.90	2.99	68.89	3.65	81.54	3.12	66.22	3.44	73.78	2.47	71.78	2.11

Statistical Tests

Station	1995 vs. 1996			1995 vs. 1997			1995 vs. 1998			1995 vs. 1999			1995 vs. 2000		
	Δ	z	p	Δ	z	p	Δ	z	p	Δ	z	p	Δ	z	p
Total Score	4.32	1.38	.17	2.44	0.66	.51	5.86	1.78	.08	6.56	1.77	.08	11.06	4.21	<.01
Density	8.58	1.57	.12	6.81	1.26	.21	2.86	0.51	.61	3.00	0.50	.62	9.07	1.82	.07
Sugar & Starch Indicators	3.74	0.53	.60	5.01	0.65	.52	11.37	1.70	.09	9.80	1.31	.19	18.62	3.10	<.01
Microscope	9.49	1.69	.09	10.94	2.05	.04	16.28	3.43	<.01	15.45	2.86	<.01	8.51	1.56	.12
Rock Identification	1.26	0.27	.79	-12.68	-2.30	.02	4.34	0.88	.38	4.34	0.88	.38	9.25	2.27	.02
Instruments	1.99	0.42	.67	14.64	3.39	<.01	-0.67	-0.15	.88	6.88	1.77	.08	4.88	1.33	.18

Table 65
Iowa
Science Literacy Test
Student Means
Percent Correct on Multiple Choice Items

Standard	Comparison (1995)		SS&C 1 (1996)		SS&C 2 (1997)		SS&C 3 (1998)		SS&C 4 (1999)		SS&C 5 (2000)	
	n = 194		n = 189		n = 185		n = 173		n = 187		n = 161	
	mean	s.e.	mean	s.e.	mean	s.e.	mean	s.e.	mean	s.e.	mean	s.e.
Total Score	67.32	0.83	59.88	1.04	62.78	0.85	61.96	0.78	60.50	0.86	60.22	0.98
Science as Inquiry	72.59	1.26	62.19	1.39	67.13	1.35	68.26	1.16	64.66	1.39	63.75	1.52
Physical Science	70.40	1.17	60.49	1.51	60.90	1.43	64.02	1.38	61.45	1.44	61.08	1.58
Life Science	67.87	1.20	65.30	1.27	66.76	1.08	65.32	1.22	65.20	1.13	63.51	1.23
Earth & Space Sciences	59.75	1.18	50.26	1.26	53.33	1.13	50.00	1.16	49.82	1.12	48.60	1.37
Science & Technology	52.71	1.21	50.99	1.25	54.93	1.25	51.30	1.30	52.34	1.35	51.48	1.25
Science in Personal & Social Perspectives	69.54	1.46	59.52	1.68	64.10	1.31	62.52	1.40	58.65	1.46	59.63	1.59
History & Nature of Science	73.43	1.05	67.03	1.33	69.52	1.12	68.70	1.03	68.37	1.14	70.04	1.25

Statistical Tests

Standard	1995 vs. 1996			1995 vs. 1997			1995 vs. 1998			1995 vs. 1999			1995 vs. 2000		
	Δ	z	p	Δ	z	p	Δ	z	p	Δ	z	p	Δ	z	p
Total Score	-7.44	-5.56	<.01	-4.54	-3.82	<.01	-5.36	-4.70	<.01	-6.82	-5.70	<.01	-7.10	-5.52	<.01
Science as Inquiry	-10.39	-5.54	<.01	-5.46	-2.97	<.01	-4.33	-2.53	.01	-7.93	-4.23	<.01	-8.84	-4.47	<.01
Physical Science	-9.91	-5.18	<.01	-9.50	-5.14	<.01	-6.39	-3.52	<.01	-8.95	-4.82	<.01	-9.33	-4.74	<.01
Life Science	-2.57	-1.47	.14	-1.11	-0.69	.49	-2.55	-1.50	.13	-2.67	-1.62	.11	-4.36	-2.54	.01
Earth & Space Sciences	-9.49	-5.49	<.01	-6.42	-3.93	<.01	-9.75	-5.89	<.01	-9.93	-6.11	<.01	-11.15	-6.17	<.01
Science & Technology	-1.71	-0.98	.33	2.23	1.28	.22	-1.41	-0.79	.43	-0.37	-0.20	.84	-1.23	-0.71	.48
Science in Personal & Social Perspectives	-10.02	-4.50	<.01	-5.45	-2.78	.01	-7.02	-3.47	<.01	-10.90	-5.28	<.01	-9.92	-4.59	<.01
History & Nature of Science	-6.40	-3.78	<.01	-3.91	-2.54	.01	-4.74	-3.21	<.01	-5.07	-3.26	<.01	-3.39	-2.08	.04

Table 66
Iowa
Hands-On Full Investigation
Student Means
Percent Correct by Total Score and Subscores

	Comparison (1995)		SS&C 1 (1996)		SS&C 2 (1997)		SS&C 3 (1998)		SS&C 4 (1999)		SS&C 5 (2000)	
	n = 6		n = 6		n = 6		n = 6		n = 6		n = 6	
	mean	s.e.	mean	s.e.	mean	s.e.	mean	s.e.	mean	s.e.	mean	s.e.
Total Score	67.78	12.13	68.44	7.35	80.33	6.24	85.44	5.05	68.00	8.66	86.56	5.66
Number of Conditions	83.33	16.67	70.00	13.42	93.33	6.67	96.67	3.33	73.33	12.29	96.67	3.33
Access to Conditions	70.83	16.35	66.67	10.54	75.00	6.46	79.17	10.03	58.33	5.27	75.00	9.13
Amount of Conditions	54.17	17.58	66.67	8.33	83.33	5.27	87.50	5.59	83.33	10.54	100.00	0.00
Method of Measurement	75.00	11.18	66.67	10.54	83.33	10.54	75.00	17.08	58.33	20.07	83.33	10.54
Number of Bugs	55.56	14.05	72.22	10.24	66.67	12.17	88.89	7.03	66.67	0.00	77.78	14.05

Statistical Tests

	1995 vs. 1996			1995 vs. 1997			1995 vs. 1998			1995 vs. 1999			1995 vs. 2000		
	Δ	z	p	Δ	z	p	Δ	z	p	Δ	z	p	Δ	z	p
Total Score	0.67	0.05	.96	12.56	0.92	.36	17.67	1.34	.18	0.22	0.01	.99	18.78	1.40	.16
Number of Conditions	-13.33	-0.62	.54	10.00	0.56	.58	13.33	0.78	.44	-10.00	-0.48	.63	13.33	0.78	.44
Access to Conditions	-4.17	-0.21	.83	4.17	0.24	.81	8.33	0.43	.67	-12.50	-0.73	.47	4.17	0.22	.83
Amount of Conditions	12.50	0.64	.52	29.16	1.59	.11	33.33	1.81	.07	29.17	1.42	.16	45.83	2.61	.01
Method of Measurement	-8.33	-0.54	.59	8.33	0.54	.59	0.00	0.00	1.00	-16.67	-0.73	.46	8.33	0.54	.56
Number of Bugs	16.67	0.96	.34	11.11	0.60	.49	33.33	2.12	.03	11.11	0.79	.43	22.22	1.12	.26

Table 67
Iowa
Written Full Investigation
Student Means
Percent Correct by Total Score and Subscores

	Comparison (1995)		SS&C 1 (1996)		SS&C 2 (1997)		SS&C 3 (1998)		SS&C 4 (1999)		SS&C 5 (2000)	
	n = 5		n = 5		n = 6		n = 5		n = 6		n = 6	
	mean	s.e.	mean	s.e.	mean	s.e.	mean	s.e.	mean	s.e.	mean	s.e.
Total Score	75.00	19.36	80.27	5.82	70.72	7.48	88.33	4.86	81.56	4.27	70.83	6.79
Number of Conditions	80.00	20.00	88.00	8.00	80.00	10.33	100.00	0.00	96.67	3.33	83.33	10.85
Access to Conditions	75.00	19.36	70.00	9.35	54.17	4.17	75.00	7.91	83.33	10.54	50.00	12.91
Amount of Conditions	80.00	20.00	100.00	0.00	91.67	8.33	100.00	0.00	50.00	22.36	87.50	8.54
Method of Measurement	60.00	24.49	70.00	20.00	66.67	16.67	80.00	12.25	100.00	0.00	50.00	22.36
Number of Bugs	80.00	20.00	73.33	12.44	61.11	5.56	86.67	13.33	77.78	11.11	83.33	7.45

Statistical Tests

	1995 vs. 1996			1995 vs. 1997			1995 vs. 1998			1995 vs. 1999			1995 vs. 2000		
	Δ	z	p	Δ	z	p	Δ	z	p	Δ	z	p	Δ	z	p
Total Score	5.27	0.26	.79	-4.28	-0.21	.83	13.33	0.67	.50	6.56	0.33	.74	-4.17	-0.20	.84
Number of Conditions	8.00	0.37	.71	0.00	0.00	1.00	20.00	1.00	.32	16.67	0.82	.41	3.33	0.15	.88
Access to Conditions	-5.00	-0.23	.82	-20.83	-1.05	.29	0.00	0.00	1.00	8.33	0.38	.70	-25.00	-1.07	.28
Amount of Conditions	20.00	1.00	.32	11.67	0.54	.59	20.00	1.00	.32	-30.00	-1.00	.32	7.50	0.34	.73
Method of Measurement	10.00	0.32	.75	6.67	0.23	.82	20.00	0.73	.47	40.00	1.63	.10	-10.00	-0.30	.76
Number of Bugs	-6.67	-0.28	.78	-18.89	-0.91	.36	6.67	0.28	.78	-2.22	-0.10	.92	3.33	0.16	.87

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Table 68
Montana
Student Questionnaire
Student Means
Percent of Time Spent by Class Activities in SS&C and Comparison Classes

Activity	Comparison (1995)		SS&C 1 (1996)		SS&C 2 (1997)		SS&C 3 (1998)		SS&C 4 (1999)		SS&C 5 (2000)	
	n = 228		n = 88		n = 82		n = 137		n = 123		n = 147	
	mean	s.e.	mean	s.e.	mean	s.e	mean	s.e	mean	s.e	mean	s.e
Inquiry	28.99	0.34	31.19	0.46	31.20	0.53	32.89	0.49	32.57	0.40	33.03	0.36
Group	27.36	0.28	34.46	0.46	33.80	0.59	34.20	0.43	34.11	0.36	34.28	0.31
Traditional	22.19	0.33	16.92	0.56	17.56	0.44	16.65	0.42	17.66	.41	17.07	0.37
Other	21.47	0.26	17.43	0.39	14.45	0.48	16.26	0.27	15.66	0.29	15.62	.26

Statistical Tests

Activity	1995 vs. 1996			1995 vs. 1997			1995 vs. 1998			1995 vs. 1999			1995 vs. 2000		
	Δ	z	p	Δ	z	p	Δ	z	p	Δ	z	p	Δ	z	p
Inquiry	2.20	3.85	<.01	2.21	3.49	<.01	3.90	6.56	<.01	3.58	6.77	<.01	4.04	8.14	<.01
Group	7.10	13.23	<.01	6.44	9.79	<.01	6.84	13.26	<.01	6.75	14.87	<.01	6.92	16.47	<.01
Traditional	-5.26	-8.17	<.01	-4.63	-8.44	<.01	-5.53	-10.46	<.01	-4.53	-8.69	<.01	-5.12	-10.43	<.01
Other	-4.03	-8.54	<.01	-4.02	-7.36	<.01	-5.21	-13.88	<.01	-5.80	-14.78	<.01	-5.84	-15.80	<.01

Table 69
Montana
Student Questionnaire
Student Means
Frequency of Class Activities in SS&C and Comparison Classes

Activity	Comparison (1995)			SS&C 1 (1996)			SS&C 2 (1997)			SS&C 3 (1998)			SS&C 4 (1999)			SS&C 5 (2000)		
	mean	s.e.	n	mean	s.e.	n	mean	s.e.	n	mean	s.e.	n	mean	s.e.	n	mean	s.e.	n
Inquiry	3.25	0.05	234	3.66	0.08	95	3.49	0.10	83	3.65	0.07	139	3.83	0.07	128	3.89	0.05	153
Group	3.06	0.05	236	3.98	0.06	98	3.75	0.09	83	3.77	0.06	140	3.98	0.06	132	4.03	0.05	151
Traditional	2.49	0.05	235	1.97	0.07	99	1.98	0.08	82	1.84	0.05	142	2.10	0.06	131	2.04	0.06	152
Other	2.40	0.04	234	2.00	0.05	100	1.89	0.05	83	1.78	0.03	140	1.84	0.04	134	1.85	0.04	149

1 = Never, 2 = Less than once a week, 3 = About once a week, 4 = Several times a week, 5=Almost every day

Statistical Tests

Activity	1995 vs. 1996			1995 vs. 1997			1995 vs. 1998			1995 vs. 1999			1995 vs. 2000		
	Δ	t	p	Δ	t	p	Δ	t	p	Δ	t	p	Δ	t	p
Inquiry	0.40	4.09	<.01	0.24	2.21	.03	0.40	4.42	<.01	0.58	6.41	<.01	0.64	7.93	<.01
Group	0.92	11.11	<.01	0.69	7.17	<.01	0.71	9.09	<.01	0.93	11.77	<.01	0.97	13.29	<.01
Traditional	-0.52	-5.97	<.01	-0.52	-5.59	<.01	-0.65	-8.78	<.01	-0.39	-4.87	<.01	-0.46	-6.05	<.01
Other	-0.40	-5.92	<.01	-0.51	-7.18	<.01	-0.62	-10.89	<.01	-0.56	-9.14	<.01	-0.55	-9.80	<.01

Table 70
Montana
Student Questionnaire
Student Means
Frequency of Inquiry Class Activities

Activity	Comparison (1995)		SS&C 1 (1996)		SS&C 2 (1997)		SS&C 3 (1998)		SS&C 4 (1999)		SS&C 5 (2000)	
	n = 234		n = 95		n = 83		n = 139		n = 128		n = 153	
	mean	s.e.	mean	s.e.	mean	s.e	mean	s.e	mean	s.e	mean	s.e
Total (Combined Inquiry)	3.25	0.05	3.66	0.08	3.49	0.10	3.65	0.07	3.83	0.07	3.89	0.05
Demonstration of a scientific principle	3.08	0.06	3.36	0.10	3.25	0.11	3.12	0.08	3.42	0.09	3.40	0.07
Ask students to suggest hypotheses	3.19	0.07	4.07	0.11	3.86	0.12	4.03	0.10	4.21	0.09	4.28	0.08
Ask students to interpret data	3.50	0.07	3.74	0.12	3.49	0.13	3.87	0.09	3.99	0.10	4.20	0.07
Relate previous work to current topic	3.22	.07	3.44	0.11	3.36	0.13	3.56	0.10	3.69	0.10	3.69	0.09

1 = Never, 2 = Less than once a week, 3 = About once a week, 4 = Several times a week, 5 = Almost every day

Statistical Tests

Activity	1995 vs. 1996			1995 vs. 1997			1995 vs. 1998			1995 vs. 1999			1995 vs. 2000		
	Δ	t	p	Δ	t	p	Δ	t	p	Δ	t	p	Δ	t	p
Total (Combined Inquiry)	0.40	4.09	<.01	0.24	2.21	.03	0.40	4.42	<.01	0.58	6.41	<.01	0.64	7.93	<.01
Demonstration of a scientific principle	0.27	2.31	.02	0.17	1.33	.19	0.04	0.34	.74	0.33	3.09	<.01	0.31	3.16	<.01
Ask students to suggest hypotheses	0.87	6.77	<.01	0.66	4.67	<.01	0.83	7.02	<.01	1.02	8.73	<.01	1.09	10.10	<.01
Ask students to interpret data	0.24	1.86	.06	-0.02	-0.01	.99	0.38	3.34	<.01	0.50	4.21	<.01	0.70	6.76	<.01
Relate previous work to current topic	0.22	1.64	.10	0.14	0.95	.35	0.34	2.80	<.01	0.46	3.75	<.01	0.47	4.05	<.01

Table 71
Montana
Student Questionnaire
Student Means
Frequency of Group Class Activities

Activity	Comparison (1995)		SS&C 1 (1996)		SS&C 2 (1997)		SS&C 3 (1998)		SS&C 4 (1999)		SS&C 5 (2000)	
	n = 236		n = 98		n = 83		n = 140		n = 132		n = 151	
	mean	s.e.	mean	s.e.	mean	s.e	mean	s.e	mean	s.e	mean	s.e
Total (Combined Group)	3.06	0.05	3.98	0.06	3.75	0.09	3.77	0.06	3.98	0.06	4.03	0.05
Do experiments with other students	2.58	0.06	4.16	0.07	3.98	0.11	3.96	0.08	4.31	0.07	4.25	0.06
Work in groups	3.64	0.07	4.06	0.09	3.71	0.13	3.87	0.09	4.17	0.08	4.26	0.07
Share results from experiments	2.97	0.07	3.73	0.10	3.57	0.13	3.50	0.09	3.50	0.10	3.57	0.09

1 = Never, 2 = Less than once a week, 3 = About once a week, 4 = Several times a week, 5 = Almost every day

Statistical Tests

Activity	1995 vs. 1996			1995 vs. 1997			1995 vs. 1998			1995 vs. 1999			1995 vs. 2000		
	Δ	t	p	Δ	t	p	Δ	t	p	Δ	t	p	Δ	t	p
Total (Combined Group)	0.92	11.11	<.01	0.69	7.17	<.01	0.71	9.09	<.01	0.93	11.77	<.01	0.97	13.29	<.01
Do experiments with other students	1.58	15.95	<.01	1.40	12.12	<.01	1.39	14.48	<.01	1.73	18.81	<.01	1.68	19.13	<.01
Work in groups	0.42	3.63	<.01	0.07	0.54	.59	0.24	2.15	.03	0.54	4.97	<.01	0.63	6.24	<.01
Share results from experiments	0.76	6.31	<.01	0.60	4.36	<.01	0.53	4.78	<.01	0.53	4.46	<.01	0.60	5.39	<.01

Table 72
Montana
Student Questionnaire
Student Means
Frequency of Traditional Class Activities

Activity	Comparison (1995)		SS&C 1 (1996)		SS&C 2 (1997)		SS&C 3 (1998)		SS&C 4 (1999)		SS&C 5 (2000)	
	n = 235		n = 99		n = 82		n = 142		n = 131		n = 152	
	mean	s.e.	mean	s.e	mean	s.e	mean	s.e	mean	s.e	mean	s.e
Total (Combined Traditional)	2.49	0.05	1.97	0.07	1.98	0.08	1.84	0.05	2.10	0.06	2.04	0.06
Read articles on science	2.63	0.07	2.03	0.09	1.98	0.10	1.87	0.08	2.38	0.08	2.20	0.07
Do oral or written reports	1.90	0.04	1.55	0.10	1.42	0.08	1.46	0.06	1.55	0.08	1.40	0.07
Read other science materials	2.95	0.07	2.44	0.13	2.52	0.15	2.19	0.10	2.41	0.11	2.50	0.10

1 = Never, 2 = Less than once a week, 3 = About once a week, 4 = Several times a week, 5 = Almost every day

Statistical Tests

Activity	1995 vs. 1996			1995 vs. 1997			1995 vs. 1998			1995 vs. 1999			1995 vs. 2000		
	Δ	t	p	Δ	t	p	Δ	t	p	Δ	t	p	Δ	t	p
Total (Combined Traditional)	-0.52	-5.97	<.01	-0.52	-5.59	<.01	-0.65	-8.78	<.01	-0.39	-4.87	<.01	-0.46	-6.05	<.01
Read articles on science	-0.60	-5.09	<.01	-0.66	-5.13	<.01	-0.77	-7.19	<.01	-0.26	-2.39	.02	-0.43	-4.19	<.01
Do oral or written reports	-0.35	-3.83	<.01	-0.48	-5.75	<.01	-0.43	-6.32	<.01	-0.35	-4.40	<.01	-0.50	-6.83	<.01
Read other science materials	-0.51	-3.57	<.01	-0.42	-2.74	<.01	-0.79	-6.09	<.01	-0.54	-4.25	<.01	-0.44	-3.56	<.01

Table 73
Montana
Student Questionnaire
Student Means
Frequency of Other Class Activities

Activity	Comparison (1995)		SS&C 1 (1996)		SS&C 2 (1997)		SS&C 3 (1998)		SS&C 4 (1999)		SS&C 5 (2000)	
	n = 234		n = 100		n = 83		n = 140		n = 134		n = 149	
	mean	s.e.	mean	s.e	mean	s.e	mean	s.e	mean	s.e	mean	s.e
Total (Combined Other)	2.40	0.04	2.00	0.05	1.89	0.05	1.78	0.03	1.84	0.04	1.85	0.04
Watch films, slides, or videos	2.69	0.05	2.35	0.07	2.54	0.06	2.28	0.05	2.48	0.07	2.41	0.05
Go outside for class instruction	2.11	0.05	1.67	0.07	1.23	0.06	1.29	0.05	1.19	0.05	1.29	0.05

1 = Never, 2 = Less than once a week, 3 = About once a week, 4 = Several times a week, 5 = Almost every day

Statistical Tests

Activity	1995 vs. 1996			1995 vs. 1997			1995 vs. 1998			1995 vs. 1999			1995 vs. 2000		
	Δ	t	p	Δ	t	p	Δ	t	p	Δ	t	p	Δ	t	p
Total (Combined Other)	-0.40	-5.92	<.01	-0.51	-7.18	<.01	-0.62	-10.89	<.01	-0.56	-9.14	<.01	-0.55	-9.80	<.01
Watch films, slides, or videos	-0.33	-3.78	<.01	-0.14	-1.56	.12	-0.40	-5.35	<.01	-0.21	-2.54	.01	-0.28	-3.73	<.01
Go outside for class instruction	-0.44	-5.03	<.01	-0.88	-9.71	<.01	-0.82	-11.28	<.01	-0.92	-12.23	<.01	-0.82	-11.57	<.01

Table 74
Montana
Teacher Questionnaire
Individual Means
Frequency of Class Activities

Activity	Comparison (1995)		SS&C 1 (1996)		SS&C 2 (1997)		SS&C 3 (1998)		SS&C 4 (1999)		SS&C 5 (2000)	
	n = 4		n = 2		n = 2		n = 3		n = 4		n =	
	mean	s.e.	mean	s.e.	mean	s.e.	mean	s.e.	mean	s.e.	mean	s.e.
Inquiry	3.69	0.19	4.88	0.13	4.38	0.38	4.42	0.17	4.44	0.21	4.56	0.12
Traditional	3.08	0.50	2.17	0.17	1.83	0.17	1.89	0.11	1.83	0.10	2.00	0.14

1 = Never, 2 = Less than once a week, 3 = About once a week, 4 = Several times a week, 5 = Almost every day

Statistical Tests

Activity	1995 vs. 1996			1995 vs. 1997			1995 vs. 1998			1995 vs. 1999			1995 vs. 2000		
	Δ	t	p	Δ	t	p	Δ	t	p	Δ	t	p	Δ	t	p
Inquiry	1.19	4.07	.02	0.69	1.89	.13	0.73	2.78	.04	0.75	2.64	.04	0.88	3.93	<.01
Traditional	-0.92	-1.22	.29	-1.25	-1.66	.17	-1.19	-2.00	.10	-1.25	-2.47	.05	-1.08	-2.10	.08

Table 75
Montana
Teacher Questionnaire
Individual Means
Frequency of Inquiry Class Activities

Activity	Comparison (1995)		SS&C 1 (1996)		SS&C 2 (1997)		SS&C 3 (1998)		SS&C 4 (1999)		SS&C 5 (2000)	
	n = 4		n = 2		n = 2		n = 3		n = 4		n = 4	
	mean	s.e.	mean	s.e.	mean	s.e.	mean	s.e.	mean	s.e.	mean	s.e.
Total (Combined Inquiry)	3.69	0.19	4.88	0.13	4.38	0.38	4.42	0.17	4.44	0.21	4.56	0.12
Do experiments	3.50	0.29	4.50	0.50	4.50	0.50	4.00	0.00	4.75	0.25	4.25	0.25
Ask for reasons for the results of experiments	3.50	0.29	5.00	0.00	4.50	0.50	5.00	0.00	4.00	0.41	4.75	0.25
Ask students to suggest hypotheses	3.75	0.25	5.00	0.00	4.00	0.00	4.33	0.33	4.50	0.29	4.50	0.29
Ask students to interpret data	4.00	0.00	5.00	0.00	4.50	0.50	4.33	0.33	4.50	0.29	4.75	0.25

1 = Never, 2 = Less than once a week, 3 = About once a week, 4 = Several times a week, 5 = Almost every day

Statistical Tests

Activity	1995 vs. 1996			1995 vs. 1997			1995 vs. 1998			1995 vs. 1999			1995 vs. 2000		
	Δ	t	p	Δ	t	p	Δ	t	p	Δ	t	p	Δ	t	p
Total (Combined Inquiry)	1.19	4.07	.02	0.69	1.89	.13	0.73	2.78	.04	0.75	2.64	.04	0.88	3.93	<.01
Do experiments	1.00	1.89	.13	1.00	1.89	.13	0.50	1.46	.20	1.25	3.27	.02	0.75	1.96	.10
Ask for reasons for the results of experiments	1.50	3.46	.03	1.00	1.89	.13	1.50	4.39	<.01	0.50	1.00	.36	1.25	3.27	.02
Ask students to suggest hypotheses	1.25	3.33	.03	0.25	0.67	.54	0.58	1.44	.21	0.75	1.96	.10	0.75	1.96	.10
Ask students to interpret data	*Can't be calculated			0.50	1.63	.18	0.33	1.20	.29	0.50	1.73	.13	0.75	3.00	.02

* The t-test cannot be calculated because the standard error for both terms is zero.

Table 76
Montana
Teacher Questionnaire
Individual Means
Frequency of Traditional Class Activities

Activity	Comparison (1995)		SS&C 1 (1996)		SS&C 2 (1997)		SS&C 3 (1998)		SS&C 4 (1999)		SS&C 5 (2000)	
	n = 4		n = 2		n = 2		n = 3		n = 4		n = 4	
	mean	s.e.	mean	s.e.	mean	s.e.	mean	s.e.	mean	s.e.	mean	s.e.
Total (Combined Traditional)	3.08	0.50	2.17	0.17	1.83	0.17	1.89	0.11	1.83	0.10	2.00	0.14
Read articles on science	3.25	0.48	2.00	0.00	2.00	0.00	2.00	0.00	2.00	0.00	2.00	0.00
Do oral or written reports	2.50	0.65	2.00	0.00	1.50	0.50	1.67	0.33	1.50	0.29	1.25	0.25
Read other science materials	3.50	0.50	2.50	0.50	2.00	0.00	2.00	0.00	2.00	0.00	2.75	0.48

1 = Never, 2 = Less than once a week, 3 = About once a week, 4 = Several times a week, 5 = Almost every day

Statistical Tests

Activity	1995 vs. 1996			1995 vs. 1997			1995 vs. 1998			1995 vs. 1999			1995 vs. 2000		
	Δ	t	p	Δ	t	p	Δ	t	p	Δ	t	p	Δ	t	p
Total (Combined Traditional)	-0.92	-1.22	.29	-1.25	-1.66	.17	-1.19	-2.00	.10	-1.25	-2.47	.05	-1.08	-2.10	.08
Read articles on science	-1.25	-1.74	.16	-1.25	-1.74	.16	-1.25	-2.21	.08	-1.25	-2.61	.04	-1.25	-2.61	.04
Do oral or written reports	-0.50	-0.52	.63	-1.00	-0.99	.38	-0.83	-1.03	.35	-1.00	-1.41	.21	-1.25	-1.81	.12
Read other science materials	-1.00	-1.23	.29	-1.50	-2.00	.12	-1.50	-2.54	.05	-1.50	-3.00	.02	-0.75	-1.08	.32

Table 77
Montana
Classroom Observations
Percent Time Spent by Teaching Style

Style	Comparison (1995)		SS&C 1 (1996)		SS&C 2 (1997)		SS&C 3 (1998)		SS&C 4 (1999)		SS&C 5 (2000)	
	n = 7		n = 6		n = 3		n = 6		n = 5		n = 3	
	freq.	%	freq.	%	freq.	%	freq.	%	freq.	%	freq.	%
Teacher-Centered	46	68.66	10	16.13	0	0.00	4	6.90	8	16.00	0	0.00
Student- & Teacher-Centered	11	16.42	11	17.74	1	3.57	7	12.07	11	22.00	5	16.67
Student-Centered	3	4.48	32	51.61	25	89.29	41	70.69	25	50.00	23	76.67
Administrative	7	10.45	9	14.52	2	7.14	6	10.34	6	12.00	2	6.67
Other activities	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00

Statistical Tests

Style	1995 vs. 1996		1995 vs. 1997		1995 vs. 1998		1995 vs. 1999		1995 vs. 2000	
	χ^2	p	χ^2	p	χ^2	p	χ^2	p	χ^2	p
Teacher-Centered										
Student- & Teacher-Centered										
Student-Centered										
Administrative										
Other activities										
	47.33	<.01	69.85	<.01	68.87	<.01	42.42	<.01	61.50	<.01

χ^2 critical values: At .05 = 9.49; at .025 = 11.14; at .01 = 13.28

Table 78
Montana
Classroom Observations
Frequency of Student Involvement and Type of Instruction

Variable *Response*	**Comparison (1995)**		**SS&C 1 (1996)**		**SS&C 2 (1997)**		**SS&C 3 (1998)**		**SS&C 4 (1999)**		**SS&C 5 (2000)**	
	n = 7		n = 6		n = 3		n = 6		n = 5		n = 3	
	freq.	%	freq.	%	freq.	%	freq.	%	freq.	%	freq.	%
Student Involvement												
Almost always	5	71.4	5	83.3	3	100.0	5	83.3	5	100.0	2	66.7
Sometimes	2	28.6	1	16.7	0	0.0	1	16.7	0	0.0	1	33.3
Almost never	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Type of Instruction												
Traditional	7	100.0	1	16.7	0	0.0	0	0.0	0	0.0	0	0.0
Mixed	0	0.0	5	83.3	1	33.3	3	50.0	0	0.0.	0	0.0
Inquiry	0	0.0	0	0.0	2	66.7	3	50.0	4	100.0	3	100.0

Statistical Tests

Variable	1995 vs. 1996		1995 vs. 1997		1995 vs. 1998		1995 vs. 1999		1995 vs. 2000	
	χ^2	p	χ^2	p	χ^2	p	χ^2	p	χ^2	p
Student Involvement	0.26	.61	1.07	.30	0.26	.61	1.71	.19	0.02	.88
Type of Instruction	9.48	<.01	10.00	<.01	13.00	<.01	11.00	<.01	10.00	<.01

Table 79
Montana
Curriculum Verification
Number of Weeks Spent on Science Topics

Standard	Comparison (1995)		SS&C 1 (1996)		SS&C 2 (1997)		SS&C 3 (1998)		SS&C 4 (1999)		SS&C 5 (2000)	
	classes affected = 15		classes affected = 7		classes affected = 6		classes affected = 9		classes affected = 10		classes affected = 10	
	weeks	%	weeks	%	weeks	%	weeks	%	weeks	%	weeks	%
Chemistry	1.6	6.30	3.2	21.62	5.8	22.14	4.0	12.42	4.2	16.22	4.0	12.50
Biology	0.3	1.18	2.0	13.51	6.6	25.14	10.4	32.30	8.4	32.43	10.2	31.88
Earth & Space Sciences	21.3	83.86	2.6	17.57	3.6	13.74	4.8	14.91	4.6	17.76	5.8	18.13
Physics	0.0	0.00	6.0	40.54	6.0	22.90	7.4	22.98	3.2	12.36	5.8	18.13
Measurement	1.2	4.72	0.0	0.00	3.8	14.50	5.6	17.39	5.5	21.24	5.6	17.50
Science & Society	4.0	15.75	0.0	0.00	0.4	1.53	0.0	0.00	0.0	0.00	0.6	1.88
Miscellaneous	0.0	0.00	1.0	6.76	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00

Table 80
Montana
Learning Environment Inventory
Student Means

Subscale	Comparison (1995)		SS&C 1 (1996)		SS&C 2 (1997)		SS&C 3 (1998)		SS&C 4 (1999)		SS&C 5 (2000)	
	n = 238		n = 103		n = 83		n = 142		n = 136		n = 153	
	mean	s.e.	mean	s.e.	mean	s.e.	mean	s.e.	mean	s.e.	mean	s.e.
Difficulty	3.16	0.05	2.92	0.07	2.94	0.08	2.94	0.07	2.89	0.06	3.09	0.07
Relevance	3.46	0.05	3.38	0.08	3.33	0.09	3.36	0.07	3.41	0.07	3.42	0.07
Critical Voice	3.52	0.05	3.69	0.07	3.28	0.08	3.41	0.07	3.45	0.06	3.60	0.06
Involvement	3.64	0.05	3.72	0.06	3.53	0.08	3.59	0.05	3.65	0.06	3.81	0.05
Sequencing	2.59	0.05	2.81	0.08	3.06	0.10	2.85	0.07	2.94	0.07	2.91	0.07
Experimenting	2.46	0.04	2.36	0.06	2.21	0.07	2.29	0.05	2.39	0.06	2.40	0.05

1 = Almost Never, 2 = Seldom, 3 = Sometimes, 4 = Often, 5 = Almost Always

Statistical Tests

Subscale	1995 vs. 1996			1995 vs. 1997			1995 vs. 1998			1995 vs. 1999			1995 vs. 2000		
	Δ	t	p	Δ	t	p	Δ	t	p	Δ	t	p	Δ	t	p
Difficulty	-0.24	-2.51	.01	-0.22	-2.10	.04	-0.22	-2.47	.01	-0.27	-3.15	<.01	-0.07	-0.82	.41
Relevance	-0.08	-0.89	.38	-0.13	-1.30	.20	-0.10	-1.21	.23	-0.05	-0.60	.55	-0.04	-0.47	.64
Critical Voice	0.18	2.03	.04	-0.24	-2.58	.01	-0.11	-1.35	.18	-0.07	-0.89	.38	0.08	1.10	.27
Involvement	0.08	1.01	.31	-0.11	-1.26	.21	-0.05	-0.72	.47	0.01	0.18	.86	0.17	2.50	.01
Sequencing	0.22	2.50	.01	0.47	4.89	<.01	0.26	3.22	<.01	0.35	4.47	<.01	0.32	4.13	<.01
Experimenting	-0.10	-1.40	.16	-0.25	-3.12	<.01	-0.17	-2.51	.01	-0.07	-0.95	.34	-0.06	-0.88	.38

Table 81
Montana
Student Questionnaire
Student Means
Inclination to Continue Studying Science
Percentage of Students who Responded "YES"

Item	Comparison (1995)		SS&C 1 (1996)		SS&C 2 (1997)		SS&C 3 (1998)		SS&C 4 (1999)		SS&C 5 (2000)	
	n = 216		n = 93		n = 75		n = 135		n = 122		n = 147	
	mean	s.e.	mean	s.e..	mean	s.e.	mean	s.e.	mean	s.e.	mean	s.e.
Take a science class in 10th grade	93.22	1.64	89.22	3.09	92.68	2.89	91.55	2.34	95.49	1.81	94.12	1.91
Take a science class in 11th grade	73.80	2.91	71.29	4.52	70.37	5.11	76.60	3.58	69.70	4.02	76.16	3.48
Take a science class in 12th grade	46.19	3.35	46.39	5.09	51.95	5.73	41.30	4.21	44.90	4.42	45.70	4.07
Take a science class in college	54.19	3.31	47.87	5.18	52.50	5.62	49.26	4.30	52.46	4.54	52.35	4.11

Statistical Tests

Item	1995 vs. 1996			1995 vs. 1997			1995 vs. 1998			1995 vs. 1999			1995 vs. 2000		
	Δ	z	p	Δ	z	p	Δ	z	p	Δ	z	p	Δ	z	p
Take a science class in 10th grade	-4.00	-1.14	.25	-0.54	-0.16	.87	-1.67	-0.58	.56	2.27	0.93	.35	0.90	0.36	.72
Take a science class in 11th grade	-2.51	-0.47	.64	-3.43	-0.58	.56	2.80	0.61	.54	-4.10	-0.83	.41	2.36	0.52	.60
Take a science class in 12th grade	0.20	0.03	.98	5.76	0.87	.38	-4.89	-0.91	.36	-1.29	-0.23	.82	-0.49	-0.09	.93
Take a science class in college	-6.32	-1.03	.30	-1.69	-0.26	.79	-4.93	-0.91	.36	-1.73	-0.31	.76	-1.84	-0.35	.73

Table 82
Montana
Student Questionnaire
Student Means
Science Motivation
Percentage of Students who Responded "YES"

Item	Comparison (1995)		SS&C 1 (1996)		SS&C 2 (1997)		SS&C 3 (1998)		SS&C 4 (1999)		SS&C 5 (2000)	
	n = 227		n = 95		n = 78		n = 140		n = 126		n = 144	
	mean	s.e.	mean	s.e.	mean	s.e.	mean	s.e.	mean	s.e.	mean	s.e.
Do you think you will pursue a career in science?	29.06	2.97	23.23	4.27	30.49	5.12	24.11	3.62	25.95	3.84	21.85	3.37
Have activities in science class made you want to take more science?	33.05	3.09	41.58	4.93	41.98	5.52	35.21	4.02	41.35	4.29	39.74	4.00
Is your science class motivating?	45.69	3.28	57.43	4.94	55.56	5.56	43.97	4.19	52.67	4.38	49.32	4.12
Have you ever had a "totally awesome" experience in your science class?	41.10	3.21	59.22	4.87	48.19	5.52	46.48	4.20	59.26	4.24	48.30	4.07

Statistical Tests

Item	1995 vs. 1996			1995 vs. 1997			1995 vs. 1998			1995 vs. 1999			1995 vs. 2000		
	Δ	z	p	Δ	z	p	Δ	z	p	Δ	z	p	Δ	z	p
Do you think you will pursue a career in science?	-5.83	-1.12	.26	1.43	0.24	.81	-4.95	-1.06	.29	-3.11	-0.64	.52	-7.21	-1.61	.11
Have activities in science class made you want to take more science?	8.53	1.47	.14	8.93	1.41	.16	2.16	0.43	.67	8.30	1.57	.12	6.69	1.32	.19
Is your science class motivating?	11.74	1.98	.05	9.87	1.53	.13	-1.72	-0.32	.75	6.98	1.28	.20	3.63	0.69	.49
Have you ever had a "totally awesome" experience in your science class?	18.12	3.11	<.01	7.09	1.11	.27	5.38	1.02	.31	18.16	3.41	<.01	7.20	1.39	.16

Table 83 - Montana

Student Questionnaire - Student Means - Students' Attitudes toward Science

Item	Comparison (1995)		SS&C 1 (1996)		SS&C 2 (1997)		SS&C 3 (1998)		SS&C 4 (1999)		SS&C 5 (2000)	
	n = 236		n = 99		n = 82		n = 141		n = 132		n = 151	
	mean	s.e.	mean	s.e.	mean	s.e.	mean	s.e.	mean	s.e.	mean	s.e.
Science is useful to me outside of class.	3.40	0.07	3.31	0.11	3.37	0.13	3.12	0.10	3.39	0.11	3.28	0.10
The things you learn in science relate to the real world.	4.00	0.06	4.00	0.09	3.99	0.10	3.93	0.09	3.99	0.09	3.97	0.08
Much of what you learn in science classes will be useful in the future.	3.67	0.07	3.78	0.10	3.64	0.11	3.50	0.09	3.66	0.09	3.51	0.09
It is important to know some science in order to get a good job.	3.76	0.06	3.74	0.09	3.75	0.09	3.80	0.07	3.62	0.09	3.84	0.08
Science class is interesting.	2.67	0.07	3.04	0.11	2.94	0.15	2.82	0.10	2.97	0.10	2.83	0.09
Science class is fun.	2.93	0.07	3.11	0.10	3.06	0.14	3.04	0.09	3.06	0.09	3.03	0.09

1 = Strongly Disagree, 2 = Disagree, 3 = No Opinion, 4 = Agree, 5 = Strongly Agree

Statistical Tests

Item	1995 vs. 1996			1995 vs. 1997			1995 vs. 1998			1995 vs. 1999			1995 vs. 2000		
	Δ	t	p	Δ	t	p	Δ	t	p	Δ	t	p	Δ	t	p
Science is useful to me outside of class.	-0.09	-0.68	.50	-0.03	-0.19	.85	-0.28	-2.30	.02	-0.01	-0.10	.92	-0.12	-1.00	.32
The things you learn in science relate to the real world.	0.00	0.00	1.00	-0.01	-0.10	.92	-0.07	-0.68	.50	-0.01	-0.14	.89	-0.03	-0.33	.75
Much of what you learn in science classes will be useful in the future.	0.11	0.89	.38	-0.03	-0.21	.84	-0.17	-1.48	.14	-0.02	-0.02	.98	-0.16	-1.43	.15
It is important to know some science in order to get a good job.	-0.03	-0.26	.79	-0.02	-0.15	.88	0.03	0.35	.73	-0.15	-1.44	.15	0.07	0.76	.45
Science class is interesting.	0.37	2.79	<.01	0.27	1.79	.08	0.15	1.27	.21	0.30	2.44	.02	0.16	1.38	.17
Science class is fun.	0.18	1.45	.15	0.13	0.93	.35	0.11	0.96	.34	0.13	1.16	.25	0.10	0.89	.37

Table 84
Montana
Student Questionnaire
Student Means
Percent of Students Who Have Participated in Science Activities Outside of Class

Activity	Comparison (1995)		SS&C 1 (1996)		SS&C 2 (1997)		SS&C 3 (1998)		SS&C 4 (1999)		SS&C 5 (2000)	
	n = 236		n = 101		n = 81		n = 142		n = 135		n = 152	
	mean	s.e.	mean	s.e.	mean	s.e.	mean	s.e.	mean	s.e.	mean	s.e.
Talk about what you learn in science class	65.82	3.09	65.69	4.72	53.01	5.51	51.41	4.21	54.81	4.30	50.98	4.05
Watch a science program on TV	54.01	3.24	60.19	4.85	50.00	5.56	61.97	4.09	54.81	4.30	50.33	4.06
Go bird watching	14.35	2.28	14.56	3.49	20.73	4.50	16.20	3.10	10.37	2.63	9.15	2.34
Go to a science museum	34.75	3.11	34.95	4.72	25.30	4.80	30.99	3.89	25.93	3.79	26.80	3.59
Talk about science topics	54.24	3.25	59.41	4.91	46.99	5.51	48.59	4.21	48.89	4.32	46.41	4.05

Statistical Tests

Activity	1995 vs. 1996			1995 vs. 1997			1995 vs. 1998			1995 vs. 1999			1995 vs. 2000		
	Δ	z	p	Δ	z	p	Δ	z	p	Δ	z	p	Δ	z	p
Talk about what you learn in science class	-0.13	-0.02	.98	-12.81	-2.03	.04	-14.41	-2.76	.01	-11.01	-2.08	.04	-14.84	-2.91	<.01
Watch a science program on TV	6.18	1.06	.29	-4.01	-0.62	.54	7.96	1.53	.13	0.80	0.15	.88	-3.68	-0.71	.48
Go bird watching	0.21	0.05	.96	6.38	1.26	.21	1.85	0.48	.63	-3.98	-1.14	.25	-5.20	-1.59	.11
Go to a science museum	0.20	0.04	.97	-9.45	-1.44	.15	-3.76	-0.75	.45	-8.82	-1.80	.07	-7.95	-1.67	.10
Talk about science topics	5.17	0.88	.38	-7.25	-1.13	.26	-5.65	-1.06	.29	-5.35	-0.99	.32	-7.83	-1.54	.13

Table 85 – Montana: Student Questionnaire
Percent of Students Who Have Participated in Science Activities Outside of Class (continued)

Activity	Comparison (1995)		SS&C 1 (1996)		SS&C 2 (1997)		SS&C 3 (1998)		SS&C 4 (1999)		SS&C 5 (2000)	
	n = 236		n = 101		n = 81		n = 142		n = 135		n = 152	
	mean	s.e.	mean	s.e.	mean	s.e.	mean	s.e.	mean	s.e.	mean	s.e.
Build a telescope	2.97	1.11	2.91	1.67	1.20	1.20	1.41	0.99	2.96	1.46	3.27	1.44
Read books about science	28.81	2.95	24.27	4.25	29.27	5.06	22.54	3.52	25.19	3.75	22.37	3.39
Do a science experiment	34.60	3.10	33.98	4.69	36.14	5.31	26.06	3.70	32.59	4.05	36.60	3.91
Write an article for a science journal	4.22	1.31	6.80	2.49	1.20	1.20	1.41	0.99	2.96	1.46	0.65	0.65
Read a science magazine	37.55	3.15	47.57	4.94	30.86	5.16	33.80	3.98	34.81	4.12	35.29	3.88

Statistical Tests

Activity	1995 vs. 1996			1995 vs. 1997			1995 vs. 1998			1995 vs. 1999			1995 vs. 2000		
	Δ	z	p	Δ	z	p	Δ	z	p	Δ	z	p	Δ	z	p
Build a telescope	-0.06	-0.03	.98	-1.77	-1.08	.28	-1.56	-1.05	.29	-0.01	-0.01	.99	0.30	0.17	.87
Read books about science	-4.54	-0.88	.38	0.46	0.08	.94	-6.27	-1.37	.17	-3.62	-0.76	.45	-6.44	-1.43	.15
Do a science experiment	-0.62	-0.11	.91	1.54	0.25	.80	-8.54	-1.77	.08	-2.01	-0.39	.70	2.00	0.40	.69
Write an article for a science journal	2.58	0.92	.36	-3.02	-1.70	.09	-2.81	-1.71	.09	-1.26	-0.64	.52	-3.57	-2.44	.01
Read a science magazine	10.02	1.71	.09	-6.69	-1.11	.27	-3.75	-0.74	.46	-2.74	-0.53	.60	-2.26	-0.45	.65

Table 86
Montana
Teacher Questionnaire
Individual Means
Percent Time Spent in Individual Class Activities

Activity	SS&C 3 (1998)		SS&C 4 (1999)		SS&C 5 (2000)	
	n = 3		n = 4		n = 4	
	mean	s.e.	mean	s.e.	mean	s.e.
Individual Activities (Total)	10.00	0.00	8.75	2.39	13.75	3.15
Hands-on activities	20.00	20.00	36.50	18.95	18.75	9.66
Lab write-ups	26.67	3.33	33.75	9.87	68.50	14.71
Textbook seat reading	0.00	0.00	0.00	0.00	1.25	1.25
Other reading seat work	3.33	3.33	4.25	2.17	6.50	2.18
Worksheet work	3.33	3.33	3.00	2.38	0.00	0.00
Journaling	0.00	0.00	0.00	0.00	0.00	0.00
Computer work	0.00	0.00	0.00	0.00	0.00	0.00
Other	46.67	23.33	22.50	13.15	5.00	5.00

Table 87
Montana
Teacher Questionnaire
Individual Means
Percent Time Spent in Group Activities

Activity	SS&C 3 (1998)		SS&C 4 (1999)		SS&C 5 (2000)	
	n = 3		n = 4		n = 4	
	mean	s.e.	mean	s.e.	mean	s.e.
Group Activities (Total)	63.33	6.67	82.50	5.20	61.25	8.26
Hands-on activity	76.67	3.33	65.00	11.90	68.75	7.18
Small group discussion	9.33	5.36	13.25	5.06	13.75	2.39
Lab write-ups	14.00	2.08	21.25	8.26	16.25	6.25
Worksheet work	0.00	0.00	0.50	0.50	0.00	0.00
Other	0.00	0.00	0.00	0.00	1.25	1.25

Table 88
Montana
Teacher Questionnaire
Individual Means
Percent Time Spent in Whole Class Activities

Activity	SS&C 3 (1998)		SS&C 4 (1999)		SS&C 5 (2000)	
	n = 3		n = 4		n = 4	
	mean	s.e.	mean	s.e.	mean	s.e.
Whole Class Activities (Total)	26.67	6.67	11.25	1.25	25.00	5.40
Lecture	33.33	6.67	32.50	11.09	26.00	13.08
Class discussion	46.67	6.67	51.25	11.97	60.25	15.73
Demonstration	20.00	0.00	16.25	8.00	14.25	5.14

Table 89
Montana
Achievement Scores
Percent Correct on Achievement Tests

Test	Comparison (1995)			SS&C 1 (1996)			SS&C 2 (1997)			SS&C 3 (1998)			SS&C 4 (1999)			SS&C 5 (2000)		
	mean	s.e.	n	mean	s.e.	n	mean	s.e.	n	mean	s.e.	n	mean	s.e.	n	mean	s.e.	n
Performance Test	68.34	3.35	27	76.80	2.33	28	82.05	2.73	14	75.39	4.10	15	77.28	2.88	24	77.81	2.64	15
Science Literacy Multiple Choice	61.39	0.81	288	61.00	1.20	126	60.40	1.36	91	61.85	1.02	149	61.58	1.02	156	61.55	1.10	158
Hands-On Full Investigation	59.00	13.33	6	86.00	4.10	5	67.87	9.08	5	88.33	3.57	6	85.33	12.22	5	90.53	5.07	5
Written Full Investigation	59.06	13.40	6	79.17	9.23	6	80.50	10.65	4	79.44	5.12	6	55.75	15.76	4	88.27	6.92	5
Science Literacy Open-Ended	50.95	1.22	289	53.79	2.86	33	56.52	4.47	23	41.67	4.23	19	51.82	2.52	55	41.67	2.97	50

Statistical Tests

Test	1995 vs. 1996			1995 vs. 1997			1995 vs. 1998			1995 vs. 1999			1995 vs. 2000		
	Δ	z	p	Δ	z	p	Δ	z	p	Δ	z	p	Δ	z	p
Performance Test	8.46	2.07	.04	13.71	3.17	<.01	7.05	1.33	.18	8.94	2.02	.04	9.47	2.22	.03
Science Literacy Multiple Choice	-0.39	-0.27	.79	-0.99	-0.63	.53	0.46	0.35	.73	0.19	0.14	.89	0.16	0.12	.90
Hands-On Full Investigation	27.00	1.94	.05	8.87	0.55	.58	29.33	2.12	.03	26.33	1.46	.14	31.53	2.21	.03
Written Full Investigation	20.11	1.24	.22	21.44	1.25	.21	20.39	1.42	.16	-3.31	-0.16	.87	29.21	1.94	.05
Science Literacy Open-Ended	2.84	0.91	.36	5.57	1.20	.23	-9.28	-2.11	.03	0.87	0.31	.76	-9.28	-2.89	<.01

Table 90
Montana
Lab Skills Performance Test
Student Means
Percent Correct by Total Score and Station

Station	Comparison (1995)		SS&C 1 (1996)		SS&C 2 (1997)		SS&C 3 (1998)		SS&C 4 (1999)		SS&C 5 (2000)	
	n = 27		n = 28		n = 14		n = 15		n = 24		n = 15	
	mean	s.e.	mean	s.e.	mean	s.e.	mean	s.e.	mean	s.e.	mean	s.e.
Total Score	68.34	3.35	76.80	2.33	82.05	2.73	75.39	4.10	77.28	2.88	77.81	2.64
Density	67.48	4.00	81.55	2.93	75.74	6.61	73.96	6.96	76.78	2.98	79.51	3.20
Sugar & Starch Indicators	59.19	5.89	72.52	4.82	82.47	4.58	66.11	7.65	69.44	6.10	66.30	5.76
Microscope	71.91	6.04	86.01	4.20	93.45	4.30	87.22	5.07	90.28	3.71	84.44	5.69
Rock Identification	77.98	4.08	83.63	2.54	90.08	2.58	84.44	7.24	87.04	3.91	86.11	2.89
Instruments	67.41	2.50	60.95	3.62	72.38	3.62	73.33	2.25	69.44	3.26	78.22	2.30

Statistical Tests

Station	1995 vs. 1996			1995 vs. 1997			1995 vs. 1998			1995 vs. 1999			1995 vs. 2000		
	Δ	z	p	Δ	z	p	Δ	z	p	Δ	z	p	Δ	z	p
Total Score	8.46	2.07	.04	13.17	3.17	<.01	7.05	1.33	.18	8.94	2.02	.04	9.47	2.22	.03
Density	14.07	2.84	<.01	8.27	1.07	.28	6.48	0.81	.42	9.30	1.86	.06	12.04	2.35	.02
Sugar & Starch Indicators	13.33	1.75	.08	23.28	3.12	<.01	6.92	0.72	.47	10.25	1.21	.23	7.11	0.86	.39
Microscope	14.10	1.92	.05	21.54	2.91	<.01	15.31	1.94	.05	18.36	2.59	.01	12.53	1.51	.13
Rock Identification	5.65	1.18	.24	12.10	2.51	.01	6.46	0.78	.44	9.05	1.60	.11	8.13	1.63	.10
Instruments	-6.45	-1.47	.14	4.97	1.13	.26	5.93	1.76	.08	2.04	0.50	.62	10.81	3.19	<.01

Table 91
Montana
Science Literacy Test
Student Means
Percent Correct on Multiple Choice Items

Standard	Comparison (1995)		SS&C 1 (1996)		SS&C 2 (1997)		SS&C 3 (1998)		SS&C 4 (1999)		SS&C 5 (2000)	
	n = 288		n = 126		n = 91		n = 149		n = 156		n = 158	
	mean	s.e.	mean	s.e.	mean	s.e.	mean	s.e.	mean	s.e.	mean	s.e.
Total Score	61.39	0.81	61.00	1.20	60.40	1.36	61.85	1.02	61.58	1.02	61.55	1.10
Science as Inquiry	65.88	1.12	65.58	1.69	64.14	2.25	66.75	1.49	66.96	1.61	63.41	1.56
Physical Science	61.49	1.28	61.38	1.88	61.54	2.20	65.44	1.64	63.19	1.74	64.40	1.73
Life Science	62.73	1.04	63.03	1.63	65.57	1.72	65.94	1.32	66.35	1.41	63.87	1.35
Earth & Space Sciences	53.73	1.03	53.24	1.60	52.20	1.56	50.56	1.26	50.75	1.20	54.59	1.40
Science & Technology	53.13	1.09	52.08	1.65	50.41	2.02	53.02	1.42	54.52	1.42	53.09	1.40
Science in Personal & Social Perspectives	61.28	1.23	60.45	1.78	58.15	2.19	60.46	1.67	61.81	1.67	59.28	1.79
History & Nature of Science	68.54	1.00	68.07	1.45	67.20	1.61	67.79	1.32	67.11	1.26	68.94	1.23

Statistical Tests

Standard	1995 vs. 1996			1995 vs. 1997			1995 vs. 1998			1995 vs. 1999			1995 vs. 2000		
	Δ	z	p	Δ	z	p	Δ	z	p	Δ	z	p	Δ	z	p
Total Score	-0.39	-0.27	.79	-0.99	-0.63	.53	0.46	0.35	.73	0.19	0.14	.88	0.16	0.12	.90
Science as Inquiry	-0.29	-0.14	.89	-1.74	-0.69	.49	0.87	0.47	.64	1.08	0.55	.58	-2.47	-1.28	.20
Physical Science	-0.11	-0.05	.96	0.05	0.02	.98	3.95	1.90	.06	1.71	0.79	.43	2.91	1.35	.18
Life Science	0.30	0.15	.88	2.84	1.41	.16	3.21	1.91	.06	3.61	2.07	.04	1.14	0.67	.50
Earth & Space Sciences	-0.49	-0.26	.79	-1.53	-0.82	.41	-3.17	-1.95	.05	-2.98	-1.88	.06	0.86	0.49	.62
Science & Technology	-1.04	-0.53	.60	-2.71	-1.18	.24	-0.10	-0.06	.95	1.40	0.78	.44	-0.04	-0.02	.98
Science in Personal & Social Perspectives	-0.84	-0.39	.70	-3.13	-1.25	.21	-0.83	-0.40	.69	0.52	0.25	.80	-2.00	-0.92	.36
History & Nature of Science	-0.47	-0.26	.79	-1.38	-0.70	.48	-0.75	-0.45	.65	-1.43	-0.89	.37	0.40	0.25	.80

Table 92
Montana
Hands-On Full Investigation
Student Means
Percent Correct by Total Score and Subscores

	Comparison (1995)		SS&C 1 (1996)		SS&C 2 (1997)		SS&C 3 (1998)		SS&C 4 (1999)		SS&C 5 (2000)	
	n = 6		n = 5		n = 5		n = 6		n = 5		n = 5	
	mean	s.e.	mean	s.e.	mean	s.e.	mean	s.e.	mean	s.e.	mean	s.e.
Total Score	59.00	13.33	86.00	4.10	67.87	9.08	88.33	3.57	85.33	2.22	90.53	5.07
Number of Conditions	53.33	13.33	100.00	0.00	56.00	20.40	100.00	0.00	100.00	0.00	96.00	4.00
Access to Conditions	50.00	14.43	55.00	22.91	65.00	10.00	83.33	8.33	90.00	10.00	85.00	10.00
Amount of Conditions	66.67	15.37	95.00	5.00	65.00	16.96	83.33	5.27	70.00	18.37	95.00	5.00
Method of Measurement	58.33	15.37	100.00	0.00	80.00	12.25	91.67	8.33	80.00	20.00	90.00	10.00
Number of Bugs	66.67	14.91	80.00	8.16	73.33	12.47	83.33	7.45	86.67	13.33	86.67	8.16

Statistical Tests

	1995 vs. 1996			1995 vs. 1997			1995 vs. 1998			1995 vs. 1999			1995 vs. 2000		
	Δ	z	p	Δ	z	p	Δ	z	p	Δ	z	p	Δ	z	p
Total Score	27.00	1.94	.05	8.87	0.55	.58	29.33	2.12	.03	26.33	1.46	.14	31.53	2.21	.03
Number of Conditions	46.67	3.50	<.01	2.67	0.11	.91	46.67	3.50	<.01	46.67	3.50	<.01	42.67	3.07	<.01
Access to Conditions	5.00	0.18	.86	15.00	0.85	.40	33.33	2.00	.05	40.00	2.28	.02	35.00	1.99	.05
Amount of Conditions	28.33	1.75	.08	-1.67	-0.07	.94	16.67	1.03	.30	3.33	0.14	.89	28.33	1.75	.08
Method of Measurement	41.67	2.71	.01	21.67	1.10	.27	33.33	1.91	.06	21.67	0.86	.39	31.67	1.73	.08
Number of Bugs	13.33	0.68	.50	6.67	0.31	.76	16.67	0.86	.39	20.00	0.90	.37	20.00	1.02	.31

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Table 93
Montana
Written Full Investigation
Student Means
Percent Correct by Total Score and Subscores

	Comparison (1995)		SS&C 1 (1996)		SS&C 2 (1997)		SS&C 3 (1998)		SS&C 4 (1999)		SS&C 5 (2000)	
	n = 6		n = 6		n = 4		n = 6		n = 4		n = 5	
	mean	s.e.	mean	s.e.	mean	s.e.	mean	s.e.	mean	s.e.	mean	s.e.
Total Score	59.06	13.40	79.17	9.23	80.50	10.65	79.44	5.12	55.75	15.76	88.27	6.92
Number of Conditions	63.33	17.45	83.33	16.67	90.00	10.00	100.00	0.00	60.00	24.29	88.00	12.00
Access to Conditions	58.33	15.37	62.50	15.48	87.50	7.22	75.00	11.18	43.75	15.73	70.00	9.35
Amount of Conditions	62.50	15.48	83.33	16.67	100.00	0.00	100.00	0.00	62.50	23.94	90.00	10.00
Method of Measurement	33.33	21.08	83.33	16.67	50.00	28.87	33.33	21.08	62.50	23.94	100.00	0.00
Number of Bugs	77.78	16.48	83.33	7.45	75.00	15.96	88.89	7.03	50.00	9.62	93.33	6.67

Statistical Tests

	1995 vs. 1996			1995 vs. 1997			1995 vs. 1998			1995 vs. 1999			1995 vs. 2000		
	Δ	z	p	Δ	z	p	Δ	z	p	Δ	z	p	Δ	z	p
Total Score	20.11	1.24	.22	21.44	1.25	.21	20.39	1.42	.16	-3.31	-0.16	.87	29.21	1.94	.05
Number of Conditions	20.00	0.83	.41	26.67	1.33	.18	36.67	2.10	.04	-3.33	-0.11	.91	24.67	1.16	.25
Access to Conditions	4.17	0.19	.85	29.17	1.72	.09	16.67	0.88	.38	-14.58	-0.66	.51	11.67	0.65	.52
Amount of Conditions	20.83	0.92	.36	37.50	2.42	.02	37.50	2.42	.02	0.00	0.00	1.00	27.50	1.49	.14
Method of Measurement	50.00	1.86	.06	16.67	0.47	.64	0.00	0.00	.00	29.17	0.91	.36	66.67	3.16	.00
Number of Bugs	5.56	0.31	.76	-2.78	-0.12	.90	11.11	0.62	.54	-27.78	-1.46	.14	15.56	0.87	.38

Table 94
New York
Student Questionnaire
Student Means
Percent of Time Spent by Class Activities in SS&C and Comparison Classes

Activity	Comparison (1995)		SS&C 1 (1996)		SS&C 2 (1997)		SS&C 3 (1998)		SS&C 4 (1999)		SS&C 5 (2000)	
	n = 11		n = 12		n = 13		n = 13		n = 11		n = 3	
	mean	s.e.	mean	s.e.	mean	s.e	mean	s.e	mean	s.e	mean	s.e
Inquiry	38.37	1.96	30.04	1.48	30.69	0.97	32.19	1.95	32.53	1.85	32.78	2.11
Group	26.12	1.93	36.20	1.08	33.65	0.82	34.97	2.91	31.07	1.19	31.44	1.21
Traditional	17.31	1.77	16.51	0.90	18.78	1.50	14.90	1.42	19.24	1.85	16.87	1.56
Other	18.20	1.25	17.25	1.46	16.88	1.19	17.94	1.58	17.16	1.28	18.90	2.66

Statistical Tests

Activity	1995 vs. 1996			1995 vs. 1997			1995 vs. 1998			1995 vs. 1999			1995 vs. 2000		
	Δ	z	p	Δ	z	p	Δ	z	p	Δ	z	p	Δ	z	p
Inquiry	-8.34	-3.39	<.01	-7.68	-3.51	<.01	-6.18	-2.23	.03	-5.85	-2.16	.03	-5.59	-1.94	.05
Group	10.09	4.56	<.01	7.53	3.60	<.01	8.86	2.54	.01	4.95	2.18	.03	5.33	2.34	.02
Traditional	-0.80	-0.40	.69	1.47	0.63	.53	-2.41	-1.06	.29	1.93	0.75	.45	-0.44	-0.18	.86
Other	-0.95	-0.49	.62	-1.32	-0.76	.45	-0.26	-0.13	.90	-1.04	-0.58	.56	0.70	0.24	.81

Table 95
New York
Student Questionnaire
Student Means
Frequency of Class Activities in SS&C and Comparison Classes

Activity	Comparison (1995)			SS&C 1 (1996)			SS&C 2 (1997)			SS&C 3 (1998)			SS&C 4 (1999)			SS&C 5 (2000)		
	mean	s.e.	n	mean	s.e.	n	mean	s.e.	n	mean	s.e.	n	mean	s.e.	n	mean	s.e.	n
Inquiry	3.77	0.32	11	3.60	0.29	12	3.73	0.17	14	3.45	0.25	15	3.77	0.29	13	3.13	0.30	4
Group	2.59	0.21	13	4.31	0.15	13	4.17	0.18	14	3.67	0.26	14	3.47	0.22	15	3.08	0.21	4
Traditional	1.82	0.19	13	1.97	0.14	13	2.31	0.21	14	1.64	0.24	14	2.33	0.33	13	1.67	0.19	3
Other	1.81	0.11	13	2.04	0.17	13	2.00	0.17	14	2.17	0.26	15	2.10	0.23	15	1.80	0.26	5

1 = Never, 2 = Less than once a week, 3 = About once a week, 4 = Several times a week, 5=Almost every day

Statistical Tests

Activity	1995 vs. 1996			1995 vs. 1997			1995 vs. 1998			1995 vs. 1999			1995 vs. 2000		
	Δ	t	p	Δ	t	p	Δ	t	p	Δ	t	p	Δ	t	p
Inquiry	-0.17	-0.40	.70	-0.04	-0.12	.91	-0.32	-0.81	.42	-0.03	-0.01	.99	-0.65	-1.15	.27
Group	1.72	6.74	<.01	1.58	5.81	<.01	1.08	3.23	<.01	0.88	2.84	<.01	0.49	1.24	.23
Traditional	0.15	0.65	.52	0.49	1.75	.09	-0.18	-0.57	.57	0.51	1.36	.19	-0.15	-0.38	.71
Other	0.23	1.13	.27	0.19	0.93	.36	0.36	1.22	.23	0.29	1.10	.28	-0.08	-0.03	.97

Table 96
New York
Student Questionnaire
Student Means
Frequency of Inquiry Class Activities

Activity	Comparison (1995)		SS&C 1 (1996)		SS&C 2 (1997)		SS&C 3 (1998)		SS&C 4 (1999)		SS&C 5 (2000)	
	n = 11		n = 12		n = 14		n = 15		n = 13		n = 4	
	mean	s.e.	mean	s.e.	mean	s.e	mean	s.e	mean	s.e	mean	s.e
Total (Combined Inquiry)	3.77	0.32	3.60	0.29	3.73	0.17	3.45	0.25	3.77	0.29	3.13	0.30
Demonstration of a scientific principle	3.50	0.47	3.85	0.32	3.73	0.30	3.73	0.30	3.73	0.34	3.60	0.40
Ask students to suggest hypotheses	4.00	0.36	3.50	0.44	4.20	0.17	3.40	0.38	3.73	0.33	2.60	0.40
Ask students to interpret data	3.75	0.33	3.69	0.26	3.43	0.31	3.60	0.29	3.77	0.32	3.00	0.41
Relate previous work to current topic	3.69	0.35	3.38	0.27	3.47	0.22	3.07	0.42	3.80	0.34	2.80	0.37

1 = Never, 2 = Less than once a week, 3 = About once a week, 4 = Several times a week, 5 = Almost every day

Statistical Tests

Activity	1995 vs. 1996			1995 vs. 1997			1995 vs. 1998			1995 vs. 1999			1995 vs. 2000		
	Δ	t	p	Δ	t	p	Δ	t	p	Δ	t	p	Δ	t	p
Total (Combined Inquiry)	-0.17	-0.40	.70	-0.04	-0.12	.91	-0.32	-0.81	.42	-0.03	-0.01	.99	-0.65	-1.15	.27
Demonstration of a scientific principle	0.35	0.62	.54	0.23	0.44	.67	0.23	0.44	.67	0.23	0.41	.69	0.10	0.13	.90
Ask students to suggest hypotheses	-0.50	-0.89	.38	0.20	0.52	.61	-0.60	-1.15	.26	-0.27	-0.55	.59	-1.40	-2.21	.04
Ask students to interpret data	-0.06	-0.14	.89	-0.32	-0.71	.48	-0.15	-0.34	.73	0.02	0.04	.97	-0.75	-1.21	.25
Relate previous work to current topic	-0.31	-0.70	.49	-0.23	-0.57	.57	-0.63	-1.13	.27	0.11	0.22	.83	-0.89	-1.46	.16

Table 97
New York
Student Questionnaire
Student Means
Frequency of Group Class Activities

Activity	Comparison (1995)		SS&C 1 (1996)		SS&C 2 (1997)		SS&C 3 (1998)		SS&C 4 (1999)		SS&C 5 (2000)	
	n = 13		n = 13		n = 14		n = 14		n = 15		n = 4	
	mean	s.e.	mean	s.e.	mean	s.e	mean	s.e	mean	s.e	mean	s.e
Total (Combined Group)	2.59	0.21	4.31	0.15	4.17	0.18	3.67	0.26	3.47	0.22	3.08	0.21
Do experiments with other students	2.31	0.29	4.38	0.18	4.14	0.18	3.67	0.27	3.00	0.28	3.20	0.20
Work in groups	2.15	0.25	4.46	0.18	4.50	0.14	3.80	0.24	3.87	0.26	3.25	0.25
Share results from experiments	3.31	0.33	4.08	0.24	3.86	0.33	3.57	0.36	3.53	0.32	2.60	0.24

1 = Never, 2 = Less than once a week, 3 = About once a week, 4 = Several times a week, 5 = Almost every day

Statistical Tests

Activity	1995 vs. 1996			1995 vs. 1997			1995 vs. 1998			1995 vs. 1999			1995 vs. 2000		
	Δ	t	p	Δ	t	p	Δ	t	p	Δ	t	p	Δ	t	p
Total (Combined Group)	1.72	6.74	<.01	1.58	5.81	<.01	1.08	3.23	<.01	0.88	2.84	<.01	0.49	1.24	.23
Do experiments with other students	2.08	6.14	<.01	1.84	5.54	<.01	1.36	3.45	<.01	0.69	1.74	.09	0.89	1.84	.08
Work in groups	2.31	7.46	<.01	2.35	8.39	<.01	1.65	4.71	<.01	1.71	4.76	<.01	1.10	2.30	.04
Share results from experiments	0.77	1.90	.07	0.55	1.18	.25	0.26	0.54	.59	0.23	0.49	.63	-0.71	-1.27	.22

Table 98
New York
Student Questionnaire
Student Means
Frequency of Traditional Class Activities

Activity	Comparison (1995)		SS&C 1 (1996)		SS&C 2 (1997)		SS&C 3 (1998)		SS&C 4 (1999)		SS&C 5 (2000)	
	n = 13		n = 13		n = 14		n = 14		n = 13		n = 3	
	mean	s.e.	mean	s.e	mean	s.e	mean	s.e	mean	s.e	mean	s.e
Total (Combined Traditional)	1.82	0.19	1.97	0.14	2.31	0.21	1.64	0.24	2.33	0.33	1.67	0.19
Read articles on science	1.77	0.23	1.92	0.26	2.57	0.29	1.47	0.22	2.23	0.41	1.80	0.20
Do oral or written reports	1.15	0.10	1.62	0.18	1.57	0.20	1.60	0.19	2.07	0.32	1.25	0.25
Read other science materials	2.54	0.46	2.38	0.24	2.79	0.30	1.93	0.35	2.53	0.34	2.00	0.00

1 = Never, 2 = Less than once a week, 3 = About once a week, 4 = Several times a week, 5 = Almost every day

Statistical Tests

Activity	1995 vs. 1996			1995 vs. 1997			1995 vs. 1998			1995 vs. 1999			1995 vs. 2000		
	Δ	t	p	Δ	t	p	Δ	t	p	Δ	t	p	Δ	t	p
Total (Combined Traditional)	0.15	0.65	.52	0.49	1.75	.09	-0.18	-0.57	.57	0.51	1.36	.19	-0.15	-0.38	.71
Read articles on science	0.15	0.44	.67	0.80	2.14	.04	-0.30	-0.96	.35	0.46	0.98	.34	0.03	0.08	.94
Do oral or written reports	0.46	2.22	.04	0.42	1.80	.09	0.45	1.97	.06	0.92	2.62	.02	0.10	0.42	.68
Read other science materials	-0.15	-0.30	.77	0.25	0.46	.65	-0.61	-1.06	.30	-0.01	-0.01	.99	-0.54	-0.63	.54

Table 99
New York
Student Questionnaire
Student Means
Frequency of Other Class Activities

Activity	Comparison (1995)		SS&C 1 (1996)		SS&C 2 (1997)		SS&C 3 (1998)		SS&C 4 (1999)		SS&C 5 (2000)	
	n = 13		n = 13		n = 14		n = 15		n = 15		n = 5	
	mean	s.e.	mean	s.e	mean	s.e	mean	s.e	mean	s.e	mean	s.e
Total (Combined Other)	1.81	0.11	2.04	0.17	2.00	0.17	2.17	0.26	2.10	0.23	1.80	0.26
Watch films, slides, or videos	2.31	0.17	2.31	0.21	2.29	0.19	2.13	0.22	2.47	0.27	2.20	0.49
Go outside for class instruction	1.31	0.13	1.77	.20	1.71	0.27	2.20	0.38	1.73	0.23	1.40	0.24

1 = Never, 2 = Less than once a week, 3 = About once a week, 4 = Several times a week, 5 = Almost every day

Statistical Tests

Activity	1995 vs. 1996			1995 vs. 1997			1995 vs. 1998			1995 vs. 1999			1995 vs. 2000		
	Δ	t	p	Δ	t	p	Δ	t	p	Δ	t	p	Δ	t	p
Total (Combined Other)	0.23	1.13	.27	0.19	0.93	.36	0.36	1.22	.23	0.29	1.10	.28	-0.08	-0.03	.97
Watch films, slides, or videos	0.00	0.00	1.00	-0.02	-0.08	.93	-0.17	-0.62	.54	0.16	0.47	.64	-0.11	-0.27	.80
Go outside for class instruction	0.46	1.91	.07	0.41	1.34	.19	0.89	2.09	.05	0.43	1.55	.13	0.09	0.35	.73

Table 100
New York
Teacher Questionnaire
Individual Means
Frequency of Class Activities

Activity	Comparison (1995)		SS&C 1 (1996)		SS&C 2 (1997)		SS&C 3 (1998)		SS&C 4 (1999)		SS&C 5 (2000)	
	n = 1		n = 3		n = 4		n = 3		n = 1		n = 2	
	mean	s.e.	mean	s.e.	mean	s.e.	mean	s.e.	mean	s.e.	mean	s.e.
Inquiry	4.00	0.00	4.08	0.22	4.44	0.33	4.17	0.22	4.00	0.00	3.88	0.13
Traditional	1.67	0.00	2.33	0.19	3.00	0.24	2.11	0.48	3.00	0.00	2.50	0.17

1 = Never, 2 = Less than once a week, 3 = About once a week, 4 = Several times a week, 5 = Almost every day

Statistical Tests

Activity	1995 vs. 1996			1995 vs. 1997			1995 vs. 1998			1995 vs. 1999			1995 vs. 2000		
	Δ	t	p	Δ	t	p	Δ	t	p	Δ	t	p	Δ	t	p
Inquiry	0.08	0.19	.87	0.44	0.60	.59	0.17	0.39	.74	*Can't be calculated			-0.13	-0.58	.67
Traditional	0.67	1.73	.23	1.33	2.53	.09	0.44	0.46	.69	*Can't be calculated			0.83	2.89	.21

*The t-test cannot be calculated because the standard error for both terms is zero.

Table 101
New York
Teacher Questionnaire
Individual Means
Frequency of Inquiry Class Activities

Activity	Comparison (1995)		SS&C 1 (1996)		SS&C 2 (1997)		SS&C 3 (1998)		SS&C 4 (1999)		SS&C 5 (2000)	
	n = 1		n = 3		n = 4		n = 3		n = 1		n = 2	
	mean	s.e.	mean	s.e.	mean	s.e.	mean	s.e.	mean	s.e.	mean	s.e.
Total (Combined Inquiry)	4.00	0.00	4.08	0.22	4.44	0.33	4.17	0.22	4.00	0.00	3.88	0.13
Do experiments	4.00	0.00	4.00	0.58	4.50	0.29	4.00	1.00	4.00	0.00	4.00	0.00
Ask for reasons for the results of experiments	3.00	0.00	4.33	0.33	4.50	0.29	4.67	0.33	4.00	0.00	4.00	0.00
Ask students to suggest hypotheses	4.00	0.00	4.33	0.33	4.25	0.48	3.67	0.33	4.00	0.00	3.50	0.50
Ask students to interpret data	5.00	0.00	3.67	0.33	4.50	0.50	4.33	0.33	4.00	0.00	4.00	0.00

1 = Never, 2 = Less than once a week, 3 = About once a week, 4 = Several times a week, 5 = Almost every day

Statistical Tests

Activity	1995 vs. 1996			1995 vs. 1997			1995 vs. 1998			1995 vs. 1999			1995 vs. 2000		
	Δ	t	p	Δ	t	p	Δ	t	p	Δ	t	p	Δ	t	p
Total (Combined Inquiry)	0.08	0.19	.87	0.44	0.60	.59	0.17	0.39	.74	*Can't be calculated			-0.13	-0.58	.67
Do experiments	0.00	0.00	1.00	0.50	0.78	.50	0.00	0.00	1.00	*Can't be calculated			*Can't be calculated		
Ask for reasons for the results of experiments	1.33	2.00	.18	1.50	2.32	.10	1.67	2.50	.13	*Can't be calculated			*Can't be calculated		
Ask students to suggest hypotheses	0.33	0.50	.67	0.25	0.23	.83	-0.33	-0.50	.67	*Can't be calculated			-0.50	-0.58	.67
Ask students to interpret data	-1.33	-2.00	.18	-0.50	-0.45	.69	-0.67	-1.00	.42	*Can't be calculated			*Can't be calculated		

*The t-test cannot be calculated because the standard error for both terms is zero.

Table 102
New York
Teacher Questionnaire
Individual Means
Frequency of Traditional Class Activities

Activity	Comparison (1995)		SS&C 1 (1996)		SS&C 2 (1997)		SS&C 3 (1998)		SS&C 4 (1999)		SS&C 5 (2000)	
	n = 1		n = 3		n = 4		n = 3		n = 1		n = 2	
	mean	s.e.	mean	s.e.	mean	s.e.	mean	s.e.	mean	s.e.	mean	s.e.
Total (Combined Traditional)	1.67	0.00	2.33	0.19	3.00	0.24	2.11	0.48	3.00	0.00	2.50	0.17
Read articles on science	2.00	0.00	2.00	0.00	3.00	0.41	2.00	0.58	3.00	0.00	2.00	0.00
Do oral or written reports	1.00	0.00	3.33	0.33	3.50	0.65	2.33	0.88	2.00	0.00	3.50	0.50
Read other science materials	2.00	0.00	1.67	0.33	2.50	0.29	2.00	0.58	4.00	0.00	2.00	0.00

1 = Never, 2 = Less than once a week, 3 = About once a week, 4 = Several times a week, 5 = Almost every day

Statistical Tests

Activity	1995 vs. 1996			1995 vs. 1997			1995 vs. 1998			1995 vs. 1999			1995 vs. 2000		
	Δ	t	p	Δ	t	p	Δ	t	p	Δ	t	p	Δ	t	p
Total (Combined Traditional)	0.67	1.73	.23	1.33	2.53	.09	0.44	0.46	.69	*Can't be calculated			0.83	2.89	.21
Read articles on science	*Can't be calculated			1.00	1.10	.35	0.00	0.00	1.00	*Can't be calculated			*Can't be calculated		
Do oral or written reports	2.33	3.50	.07	2.50	1.73	.18	1.33	0.76	.53	*Can't be calculated			2.50	2.89	.21
Read other science materials	-0.33	-0.50	.67	0.50	0.78	.50	0.00	0.00	1.00	*Can't be calculated			*Can't be calculated		

*The t-test cannot be calculated because the standard error for both terms is zero.

Table 103
New York
Classroom Observations
Percent Time Spent by Teaching Style

Style	Comparison (1995)		SS&C 1 (1996)		SS&C 2 (1997)		SS&C 3 (1998)		SS&C 4 (1999)		SS&C 5 (2000)	
	n = 3		n = 6		n = 3		n = 7		n = 5		n = 1	
	freq.	%	freq.	%	freq.	%	freq.	%	freq.	%	freq.	%
Teacher-Centered	0	0.00	5	11.90	1	4.00	8	18.18	10	23.81	1	11.11
Student- & Teacher-Centered	20	76.92	15	35.71	6	24.00	9	20.45	17	40.48	0	0.00
Student-Centered	1	3.85	12	28.57	13	52.00	23	52.27	9	21.43	7	77.78
Administrative	5	19.23	6	14.29	5	20.00	2	4.55	2	4.76	0	0.00
Other activities	0	0.00	4	9.52	0	0.00	2	4.55	4	9.52	1	11.11

Statistical Tests

Style	1995 vs. 1996		1995 vs. 1997		1995 vs. 1998		1995 vs. 1999		1995 vs. 2000	
	χ^2	p	χ^2	p	χ^2	p	χ^2	p	χ^2	p
Teacher-Centered										
Student- & Teacher-Centered										
Student-Centered										
Administrative										
Other activities										
	16.18	<.01	18.55	<.01	33.03	<.01	21.36	<.01	28.77	<.01

χ^2 critical values: At .05 = 9.49; at .025 = 11.14; at .01 = 13.28

Table 104
New York
Classroom Observations
Frequency of Student Involvement and Type of Instruction

Variable *Response*	Comparison (1995)		SS&C 1 (1996)		SS&C 2 (1997)		SS&C 3 (1998)		SS&C 4 (1999)		SS&C 5 (2000)	
	n = 3		n = 6		n = 3		n = 7		n = 5		n = 1	
	freq.	%	freq.	%	freq.	%	freq.	%	freq.	%	freq.	%
Student Involvement												
Almost always	3	100.0	3	50.0	1	33.3	4	57.1	4	80.0	0	0.0
Sometimes	0	0.0	3	50.0	2	66.7	3	42.9	1	20.0	1	100.0
Almost never	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Type of Instruction												
Traditional	2	100.0	4	66.7	1	33.3	1	14.3	1	20.0	0	0.0
Mixed	0	0.0	2	33.3	1	33.3	5	71.4	4	80.0	0	0.0
Inquiry	0	0.0	0	0.0	1	33.3	1	14.3	0	0.0	1	100.0

Statistical Tests

Variable	1995 vs. 1996		1995 vs. 1997		1995 vs. 1998		1995 vs. 1999		1995 vs. 2000	
	χ^2	p	χ^2	p	χ^2	p	χ^2	p	χ^2	p
Student Involvement	2.25	.13	3.00	.08	1.84	.18	0.69	.41	4.00	.05
Type of Instruction	0.89	.35	2.22	.33	5.14	.08	3.73	.05	3.00	.08

Table 105
New York
Curriculum Verification
Number of Weeks Spent on Science Topics

Standard	Comparison (1995)		SS&C 1 (1996)		SS&C 2 (1997)		SS&C 3 (1998)		SS&C 4 (1999)		SS&C 5 (2000)
	classes affected = 3		classes affected = 4		classes affected = 4		classes affected = 5		classes affected = 3		No data for 2000
	weeks	%	weeks	%	weeks	%	weeks	%	weeks	%	
Chemistry	1.5	4.23	7.0	11.35	3.4	20.70	11.5	31.51	11.0	95.65	
Biology	5.0	14.08	25.2	40.84	5.6	34.60	7.2	19.73	0.0	0.00	
Earth & Space Sciences	24.0	67.61	6.8	11.02	2.6	16.07	9.4	26.58	0.0	0.00	
Physics	2.0	5.63	16.7	27.07	3.8	23.69	8.1	22.19	0.0	0.00	
Measurement	0.0	0.00	3.0	4.86	0.0	0.00	0.0	0.00	0.5	4.35	
Science & Society	3.0	8.45	3.0	4.86	0.8	4.94	0.0	0.00	0.0	0.00	
Miscellaneous	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	

Table 106
New York
Learning Environment Inventory
Student Means

Subscale	Comparison (1995)		SS&C 1 (1996)		SS&C 2 (1997)		SS&C 3 (1998)		SS&C 4 (1999)		SS&C 5 (2000)	
	n = 14		n = 13		n = 16		n = 15		n = 15		n = 5	
	mean	s.e.	mean	s.e.	mean	s.e.	mean	s.e.	mean	s.e.	mean	s.e.
Difficulty	3.11	0.18	2.70	0.21	2.73	0.20	2.71	0.19	2.69	0.19	2.17	0.29
Relevance	3.57	0.29	3.89	0.17	3.36	0.19	3.56	0.23	3.71	0.20	3.13	0.32
Critical Voice	4.05	0.19	3.76	0.18	3.84	0.16	3.76	0.18	3.94	0.14	3.73	0.30
Involvement	4.16	0.16	3.79	0.23	3.87	0.13	3.91	0.14	4.03	0.20	3.77	0.15
Sequencing	1.96	0.15	2.69	0.18	2.67	0.25	2.20	0.15	1.75	0.15	2.90	[illegible]
Experimenting	2.51	0.20	2.28	0.19	2.60	0.15	2.61	0.21	3.00	0.22	2.08	0.16

1 = Almost Never, 2 = Seldom, 3 = Sometimes, 4 = Often, 5 = Almost Always

Statistical Tests

Subscale	1995 vs. 1996			1995 vs. 1997			1995 vs. 1998			1995 vs. 1999			1995 vs. 2000		
	Δ	t	p	Δ	t	p	Δ	t	p	Δ	t	p	Δ	t	p
Difficulty	-0.41	-1.54	.14	-0.38	-1.44	.16	-0.40	-1.57	.13	-0.42	-1.65	.11	-0.94	-2.81	.01
Relevance	0.32	0.93	.36	-0.21	-0.64	.53	-0.02	-0.05	.96	0.14	0.39	.70	-0.44	-0.84	.41
Critical Voice	-0.29	-1.10	.28	-0.21	-0.85	.40	-0.29	-1.12	.27	-0.11	-0.48	.64	-0.32	-0.89	.39
Involvement	-0.37	-1.33	.20	-0.29	-1.42	.17	-0.25	-1.19	.24	-0.13	-0.51	.62	-0.40	-1.40	.18
Sequencing	0.73	3.15	<.01	0.71	2.37	.03	0.24	1.11	.28	-0.21	-1.04	.31	0.94	3.11	<.01
Experimenting	-0.24	-0.86	.40	0.09	0.34	.74	0.10	0.34	.74	0.49	1.64	.11	-0.43	-1.21	.24

Table 107
New York
Student Questionnaire
Student Means
Inclination to Continue Studying Science
Percentage of Students who Responded "YES"

Item	Comparison (1995)		SS&C 1 (1996)		SS&C 2 (1997)		SS&C 3 (1998)		SS&C 4 (1999)		SS&C 5 (2000)	
	n = 13		n = 10		n = 13		n = 14		n = 14		n = 5	
	mean	s.e.	mean	s.e..	mean	s.e.	mean	s.e.	mean	s.e.	mean	s.e.
Take a science class in 10th grade	84.62	10.42	92.31	7.69	100.00	0.00	100.00	0.00	86.67	9.09	100.00	0.00
Take a science class in 11th grade	92.86	7.14	92.31	7.69	100.00	0.00	93.33	6.67	86.67	9.09	100.00	0.00
Take a science class in 12th grade	69.23	13.32	58.33	14.86	85.71	9.71	80.00	10.69	86.67	9.09	20.00	20.00
Take a science class in college	53.85	14.39	70.00	15.28	64.29	13.29	57.14	13.73	57.14	13.73	40.00	24.49

Statistical Tests

Item	1995 vs. 1996			1995 vs. 1997			1995 vs. 1998			1995 vs. 1999			1995 vs. 2000		
	Δ	z	p	Δ	z	p	Δ	z	p	Δ	z	p	Δ	z	p
Take a science class in 10th grade	7.69	0.59	.56	15.38	1.48	.14	15.38	1.48	.14	2.05	0.15	.88	15.38	1.48	.14
Take a science class in 11th grade	-0.55	-0.05	.96	7.14	1.00	.32	0.47	0.05	.96	-6.19	-0.54	.59	7.14	1.00	.32
Take a science class in 12th grade	-10.90	-0.55	.58	16.48	1.00	.32	10.77	0.63	.53	17.44	1.08	.28	-49.23	-2.05	.04
Take a science class in college	16.15	0.77	.44	10.44	0.53	.60	3.29	0.17	.87	3.29	0.17	.87	-13.85	-0.49	.62

Table 108
New York
Student Questionnaire
Student Means
Science Motivation
Percentage of Students who Responded "YES"

Item	Comparison (1995)		SS&C 1 (1996)		SS&C 2 (1997)		SS&C 3 (1998)		SS&C 4 (1999)		SS&C 5 (2000)	
	n = 13		n = 11		n = 13		n = 15		n = 10		n = 5	
	mean	s.e.	mean	s.e.	mean	s.e.	mean	s.e.	mean	s.e.	mean	s.e.
Do you think you will pursue a career in science?	21.43	11.38	25.00	13.06	7.14	7.14	20.00	10.69	58.33	14.86	0.00	0.00
Have activities in science class made you want to take more science?	79.92	12.16	69.23	13.32	73.33	11.82	40.00	13.09	78.57	11.38	20.00	20.00
Is your science class motivating?	84.62	10.42	91.67	8.33	78.57	11.38	40.00	13.09	93.33	6.67	60.00	24.49
Have you ever had a "totally awesome" experience in your science class?	69.23	13.32	83.33	11.24	64.29	13.29	53.33	13.33	78.57	11.38	60.00	24.49

Statistical Tests

Item	1995 vs. 1996			1995 vs. 1997			1995 vs. 1998			1995 vs. 1999			1995 vs. 2000		
	Δ	z	p	Δ	z	p	Δ	z	p	Δ	z	p	Δ	z	p
Do you think you will pursue a career in science?	3.57	0.21	.83	-14.29	-1.06	.29	-1.43	-0.09	.93	36.90	1.97	.05	-21.43	-1.88	.06
Have activities in science class made you want to take more science?	-10.69	-0.59	.56	-6.59	-0.39	.70	-39.92	-2.23	.03	-1.35	-0.08	.94	-59.92	-2.56	.01
Is your science class motivating?	7.05	0.53	.60	-6.05	-0.39	.70	-44.62	-2.67	.01	8.71	0.70	.48	-24.62	-0.93	.35
Have you ever had a "totally awesome" experience in your science class?	14.10	0.81	.42	-4.94	-0.26	.60	-15.90	-0.84	.40	9.34	0.53	.60	-9.23	-0.33	.74

Table 109 - New York
Student Questionnaire - Student Means - Students' Attitudes toward Science

Item	Comparison (1995)		SS&C 1 (1996)		SS&C 2 (1997)		SS&C 3 (1998)		SS&C 4 (1999)		SS&C 5 (2000)	
	n = 13		n = 13		n = 14		n = 14		n = 15		n = 5	
	mean	s.e.	mean	s.e.	mean	s.e.	mean	s.e.	mean	s.e.	mean	s.e.
Science is useful to me outside of class.	3.46	0.42	3.62	0.31	3.33	0.30	3.00	0.26	3.40	0.40	2.80	0.58
The things you learn in science relate to the real world.	4.15	0.32	4.46	0.22	4.40	0.13	3.33	0.35	3.93	0.38	4.20	0.37
Much of what you learn in science classes will be useful in the future.	3.92	0.31	4.08	0.24	3.93	0.29	3.47	0.29	3.80	0.38	3.40	0.60
It is important to know some science in order to get a good job.	3.54	0.22	3.54	0.31	3.53	0.24	3.64	0.17	3.53	0.32	3.60	0.40
Science class is interesting.	4.08	0.31	3.69	0.29	3.80	0.20	2.80	0.37	3.60	0.36	3.20	0.37
Science class is fun.	3.92	0.33	3.46	0.29	3.67	0.16	3.67	0.30	3.67	0.35	3.60	0.24

1 = Strongly Disagree, 2 = Disagree, 3 = No Opinion, 4 = Agree, 5 = Strongly Agree

Statistical Tests

Item	1995 vs. 1996			1995 vs. 1997			1995 vs. 1998			1995 vs. 1999			1995 vs. 2000		
	Δ	t	p	Δ	t	p	Δ	t	p	Δ	t	p	Δ	t	p
Science is useful to me outside of class.	0.15	0.30	.77	-0.13	-0.25	.80	-0.46	-0.97	.34	-0.06	-0.11	.92	-0.66	-0.86	.40
The things you learn in science relate to the real world.	0.31	0.80	.43	0.25	0.75	.46	-0.82	-1.72	.10	-0.22	-0.44	.67	0.05	0.08	.94
Much of what you learn in science classes will be useful in the future.	0.15	0.39	.70	0.05	0.01	.99	-0.46	-1.08	.29	-0.12	-0.25	.81	-0.52	-0.85	.41
It is important to know some science in order to get a good job.	0.00	0.00	1.00	-0.05	-0.02	.99	0.10	0.38	.70	-0.05	-0.01	.99	0.06	0.15	.89
Science class is interesting.	-0.38	-0.91	.37	-0.28	-0.77	.45	-1.28	-2.61	.02	-0.48	-0.98	.33	-0.88	-1.58	.13
Science class is fun.	-0.46	-1.05	.30	-0.26	-0.73	.47	-0.26	-0.57	.57	-0.26	-0.53	.60	-0.32	-0.58	.57

Table 110
New York
Student Questionnaire
Student Means
Percent of Students Who Have Participated in Science Activities Outside of Class

Activity	Comparison (1995)		SS&C 1 (1996)		SS&C 2 (1997)		SS&C 3 (1998)		SS&C 4 (1999)		SS&C 5 (2000)	
	n = 14		n = 13		n = 14		n = 14		n = 15		n = 5	
	mean	s.e.	mean	s.e.	mean	s.e.	mean	s.e.	mean	s.e.	mean	s.e.
Talk about what you learn in science class	71.43	12.53	69.23	13.32	73.33	11.82	33.33	12.60	66.67	12.60	20.00	20.00
Watch a science program on TV	78.57	11.38	69.23	13.32	80.00	10.69	21.43	11.38	53.33	13.33	0.00	0.00
Go bird watching	7.14	7.14	15.38	10.42	6.67	6.67	6.67	6.67	20.00	10.69	0.00	0.00
Go to a science museum	28.57	12.53	61.54	14.04	26.67	11.82	46.67	13.33	20.00	10.69	40.00	24.49
Talk about science topics	71.43	12.53	61.54	14.04	66.67	12.60	20.00	10.69	53.33	13.33	40.00	24.49

Statistical Tests

Activity	1995 vs. 1996			1995 vs. 1997			1995 vs. 1998			1995 vs. 1999			1995 vs. 2000		
	Δ	z	p	Δ	z	p	Δ	z	p	Δ	z	p	Δ	z	p
Talk about what you learn in science class	-2.20	-0.12	.90	1.90	0.11	.91	-38.10	-2.14	.03	-4.76	-0.27	.79	-51.43	-2.18	.03
Watch a science program on TV	-9.34	-0.53	.60	1.43	0.09	.93	-57.14	-3.55	<.01	-25.24	-1.44	.15	-78.57	-6.90	<.01
Go bird watching	8.24	0.65	.52	-0.47	-0.05	.96	-0.47	-0.05	.96	12.86	1.00	.32	-7.14	-1.00	.32
Go to a science museum	32.97	1.75	.08	-1.90	-0.11	.91	18.10	0.99	.32	-8.57	-0.52	.62	11.43	0.42	.67
Talk about science topics	-9.89	-0.53	.60	-4.76	-0.27	.79	-51.43	-3.12	<.01	-18.10	-0.99	.32	-31.43	-1.14	.25

Table 111 – New York: Student Questionnaire
Percent of Students Who Have Participated in Science Activities Outside of Class (continued)

Activity	**Comparison (1995)**		**SS&C 1 (1996)**		**SS&C 2 (1997)**		**SS&C 3 (1998)**		**SS&C 4 (1999)**		**SS&C 5 (2000)**	
	n = 14		n = 13		n = 14		n = 14		n = 15		n = 5	
	mean	s.e.	mean	s.e.	mean	s.e.	mean	s.e.	mean	s.e.	mean	s.e.
Build a telescope	0.00	0.00	0.00	0.00	6.67	6.67	0.00	0.00	13.33	9.09	0.00	0.00
Read books about science	28.57	12.53	38.46	14.04	33.33	12.60	13.33	9.09	53.33	13.33	20.00	20.00
Do a science experiment	57.14	13.73	53.85	14.39	40.00	13.09	40.00	13.09	60.00	13.09	20.00	20.00
Write an article for a science journal	7.14	7.14	0.00	0.00	0.00	0.00	0.00	0.00	13.33	9.09	20.00	20.00
Read a science magazine	50.00	13.87	23.08	12.16	50.00	13.87	20.00	10.69	46.67	13.33	20.00	20.00

Statistical Tests

Activity	**1995 vs. 1996**			**1995 vs. 1997**			**1995 vs. 1998**			**1995 vs. 1999**			**1995 vs. 2000**		
	Δ	z	p	Δ	z	p	Δ	z	p	Δ	z	p	Δ	z	p
Build a telescope	0.00	0.00	1.00	6.67	1.00	.32	0.00	0.00	1.00	13.33	1.47	.14	0.00	0.00	1.00
Read books about science	9.89	0.53	.60	4.76	0.27	.79	-15.24	-0.98	.33	24.76	1.35	.18	-8.57	-0.36	.72
Do a science experiment	-3.29	-0.17	.87	-17.14	-0.90	.37	-17.14	-0.90	.37	2.86	0.15	.88	-37.14	-1.53	.13
Write an article for a science journal	-7.14	-1.00	.32	-7.14	-1.00	.32	-7.14	-1.00	.32	6.19	0.54	.59	12.86	0.61	.54
Read a science magazine	-26.92	-1.46	.14	0.00	0.00	1.00	-30.00	-1.71	.09	-3.33	-0.17	.87	-30.00	-1.23	.22

Table 112
New York
Teacher Questionnaire
Individual Means
Percent Time Spent in Individual Class Activities

Activity	SS&C 3 (1998)		SS&C 4 (1999)		SS&C 5 (2000)	
	n = 3		n = 1		n = 2	
	mean	s.e.	mean	s.e.	mean	s.e.
Individual Activities (Total)	33.33	12.02	5.00	0.00	20.00	0.00
Hands-on activities	11.67	7.26	75.00	0.00	7.50	7.50
Lab write-ups	43.33	24.04	20.00	0.00	27.50	2.50
Textbook seat reading	3.33	3.33	0.00	0.00	0.00	0.00
Other reading seat work	3.33	3.33	5.00	0.00	0.00	0.00
Worksheet work	16.67	12.02	0.00	0.00	45.00	5.00
Journaling	3.33	3.33	0.00	0.00	17.50	2.50
Computer work	18.33	15.90	0.00	0.00	25.00	25.00
Other	0.00	0.00	0.00	0.00	0.00	0.00

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Table 113
New York
Teacher Questionnaire
Individual Means
Percent Time Spent in Group Activities

Activity	SS&C 3 (1998)		SS&C 4 (1999)		SS&C 5 (2000)	
	n = 3		n = 1		n = 2	
	mean	s.e.	mean	s.e.	mean	s.e.
Group Activities (Total)	43.33	20.28	80.00	0.00	50.00	0.00
Hands-on activity	53.33	3.33	75.00	0.00	50.00	0.00
Small group discussion	21.67	7.26	10.00	0.00	15.00	5.00
Lab write-ups	13.33	8.82	15.00	0.00	15.00	5.00
Worksheet work	8.33	4.41	0.00	0.00	15.00	5.00
Other	3.33	3.33	0.00	0.00	0.00	0.00

Table 114
New York
Teacher Questionnaire
Individual Means
Percent Time Spent in Whole Class Activities

Activity	**SS&C 3 (1998)**		**SS&C 4 (1999)**		**SS&C 5 (2000)**	
	n = 3		n = 1		n = 2	
	mean	s.e.	mean	s.e.	mean	s.e.
Whole Class Activities (Total)	23.33	8.82	10.00	0.00	30.00	0.00
Lecture	51.67	4.41	40.00	0.00	37.50	12.50
Class discussion	41.67	7.26	40.00	0.00	25.00	0.00
Demonstration	15.00	5.00	20.00	0.00	37.50	12.50

Table 115
New York
Achievement Scores
Percent Correct on Achievement Tests

Test	Comparison (1995)			SS&C 1 (1996)			SS&C 2 (1997)			SS&C 3 (1998)			SS&C 4 (1999)			SS&C 5 (2000)		
	mean	s.e.	n	mean	s.e.	n	mean	s.e.	n	mean	s.e.	n	mean	s.e.	n	mean	s.e.	n
Performance Test	40.97	5.47	12	59.14	5.83	10	63.27	6.14	9	59.88	4.12	17	43.88	2.80	21	57.97	2.15	7
Science Literacy Multiple Choice	45.43	2.68	26	51.33	2.19	31	48.45	1.85	41	51.90	3.02	23	48.61	5.18	9	46.34	3.10	14
Hands-On Full Investigation	45.07	7.82	5	46.11	21.17	3	58.22	17.58	3	54.73	10.93	5	81.33	18.67	3	87.00	0.00	1
Written Full Investigation	40.00	11.49	5	74.89	13.75	3	84.58	6.02	4	63.27	12.03	5	18.33	18.33	2	No data for 2000		
Science Literacy Open-Ended	23.66	3.19	31	34.14	3.22	31	46.21	4.82	11	35.71	4.66	14	25.00	4.42	22	35.42	3.82	20

Statistical Tests

Test	1995 vs. 1996			1995 vs. 1997			1995 vs. 1998			1995 vs. 1999			1995 vs. 2000		
	Δ	z	p	Δ	z	p	Δ	z	p	Δ	z	p	Δ	z	p
Performance Test	18.17	2.27	.02	22.30	2.71	.01	18.91	2.76	.01	2.91	0.47	.64	17.00	2.89	<.01
Science Literacy Multiple Choice	5.90	1.70	.09	3.01	0.93	.35	6.47	1.60	.11	3.18	0.55	.58	0.91	0.22	.83
Hands-On Full Investigation	1.04	0.05	.96	13.16	.68	.50	9.67	0.72	.47	36.27	1.79	.07	41.93	5.36	<.01
Written Full Investigation	34.89	1.95	.05	44.58	3.44	<.01	23.27	1.40	.16	-21.67	-1.00	.32	No data for 2000		
Science Literacy Open-Ended	10.48	2.31	.02	22.56	3.91	<.01	12.06	2.14	.03	1.34	0.25	.80	11.76	2.36	.02

Table 116
New York
Lab Skills Performance Test
Student Means
Percent Correct by Total Score and Station

Station	Comparison (1995)		SS&C 1 (1996)		SS&C 2 (1997)		SS&C 3 (1998)		SS&C 4 (1999)		SS&C 5 (2000)	
	n = 12		n = 10		n = 9		n = 17		n = 21		n = 7	
	mean	s.e.	mean	s.e.	mean	s.e.	mean	s.e.	mean	s.e.	mean	s.e.
Total Score	40.97	5.47	59.14	5.83	63.27	6.14	59.88	4.12	43.88	2.80	57.97	2.15
Density	33.07	7.72	47.50	7.53	54.28	12.14	42.89	8.08	33.88	3.85	57.44	6.37
Sugar & Starch Indicators	40.59	6.14	45.28	10.22	64.51	8.71	59.97	7.65	30.20	4.88	36.64	2.72
Microscope	62.50	8.67	64.17	13.03	54.63	9.53	56.37	4.20	43.25	4.73	76.19	7.37
Rock Identification	46.30	9.67	73.61	8.85	76.23	7.65	81.70	4.70	58.86	6.09	69.84	6.37
Instruments	36.11	7.27	74.67	5.86	55.56	7.11	49.02	4.24	57.78	5.88	68.57	4.29

Statistical Tests

Station	1995 vs. 1996			1995 vs. 1997			1995 vs. 1998			1995 vs. 1999			1995 vs. 2000		
	Δ	z	p	Δ	z	p	Δ	z	p	Δ	z	p	Δ	z	p
Total Score	18.17	2.27	.02	22.30	2.71	.01	18.91	2.76	.01	2.91	0.47	.64	17.00	2.89	<.01
Density	14.43	1.34	.18	21.21	1.47	.14	9.82	0.88	.38	0.81	0.09	.93	24.37	2.43	.02
Sugar & Starch Indicators	4.69	0.39	.70	23.92	2.24	.03	19.38	1.98	.05	-10.38	-1.32	.19	-3.95	-0.59	.56
Microscope	1.67	0.11	.91	-7.87	-0.61	.54	-6.13	-0.64	.52	-19.25	-1.95	.05	13.69	1.20	.23
Rock Identification	27.31	2.08	.04	29.94	2.43	.02	35.40	3.29	<.01	12.57	1.10	.27	23.55	2.03	.04
Instruments	38.56	4.13	<.01	19.44	1.91	.06	12.91	1.53	.13	21.67	2.32	.02	32.46	3.84	<.01

Table 117
New York
Science Literacy Test
Student Means
Percent Correct on Multiple Choice Items

Standard	Comparison (1995) n = 26		SS&C 1 (1996) n = 31		SS&C 2 (1997) n = 41		SS&C 3 (1998) n = 23		SS&C 4 (1999) n = 9		SS&C 5 (2000) n = 14	
	mean	s.e.	mean	s.e.	mean	s.e.	mean	s.e.	mean	s.e.	mean	s.e.
Total Score	45.43	2.68	51.33	2.19	48.45	1.85	51.90	3.02	48.61	5.18	46.34	3.10
Science as Inquiry	47.20	3.57	55.72	3.52	49.67	2.42	52.96	4.56	52.53	5.20	48.70	5.52
Physical Science	41.67	3.81	51.88	4.28	48.37	3.07	53.26	4.22	43.52	9.50	44.64	4.33
Life Science	48.08	3.88	57.53	2.88	52.44	2.51	57.97	3.65	49.07	7.54	50.00	3.60
Earth & Space Sciences	37.50	2.93	37.63	2.84	39.63	2.40	41.67	3.70	40.74	6.87	38.10	5.07
Science & Technology	46.15	3.65	51.21	3.09	49.39	2.79	45.65	4.06	36.11	4.39	41.96	4.46
Science in Personal & Social Perspectives	36.54	4.92	42.20	4.13	39.63	3.21	49.28	5.21	50.93	7.41	41.67	4.94
History & Nature of Science	60.06	3.60	62.53	3.24	59.47	2.58	59.87	3.28	62.39	4.87	57.14	5.27

Statistical Tests

Standard	1995 vs. 1996			1995 vs. 1997			1995 vs. 1998			1995 vs. 1999			1995 vs. 2000		
	Δ	z	p	Δ	z	p	Δ	z	p	Δ	z	p	Δ	z	p
Total Score	5.90	1.70	.09	3.01	0.93	.35	6.47	1.60	.11	3.18	0.55	.58	0.91	0.22	.83
Science as Inquiry	8.52	1.70	.09	2.46	0.57	.57	5.76	1.00	.32	5.32	0.84	.40	1.50	0.23	.82
Physical Science	10.22	1.78	.08	6.71	1.37	.17	11.59	2.04	.04	1.85	0.18	.86	2.98	0.52	.60
Life Science	9.45	1.96	.05	4.36	0.94	.35	9.89	1.86	.06	1.00	0.12	.90	1.92	0.36	.72
Earth & Space Sciences	0.13	0.03	.98	2.13	0.56	.58	4.17	0.88	.38	3.24	0.43	.67	0.60	0.10	.92
Science & Technology	5.06	1.06	.29	3.24	0.70	.48	-0.50	-0.09	.93	-10.04	-1.76	.08	-4.19	-0.73	.47
Science in Personal & Social Perspectives	5.67	0.88	.38	3.10	0.53	.60	12.74	1.78	.08	14.39	1.62	.11	5.13	0.74	.46
History & Nature of Science	2.47	0.51	.61	-0.58	-0.13	.90	-0.19	-0.04	.97	2.33	0.39	.70	-2.92	-0.46	.65

Table 118
New York
Hands-On Full Investigation
Student Means
Percent Correct by Total Score and Subscores

	Comparison (1995)		SS&C 1 (1996)		SS&C 2 (1997)		SS&C 3 (1998)		SS&C 4 (1999)		SS&C 5 (2000)	
	n = 5		n = 3		n = 3		n = 5		n = 3		n = 1	
	mean	s.e.	mean	s.e.	mean	s.e.	mean	s.e.	mean	s.e.	mean	s.e.
Total Score	45.07	7.82	46.11	21.17	58.22	17.58	54.73	10.93	81.33	18.67	87.00	0.00
Number of Conditions	32.00	17.44	66.67	24.04	46.67	6.67	52.00	14.97	73.33	26.67	60.00	0.00
Access to Conditions	35.00	6.12	16.67	16.67	50.00	14.43	55.00	14.58	75.00	25.00	75.00	0.00
Amount of Conditions	45.00	14.58	58.33	30.05	50.00	28.87	60.00	15.00	75.00	25.00	100.00	0.00
Method of Measurement	60.00	10.00	33.33	16.67	66.67	33.33	60.00	10.00	83.33	16.67	100.00	0.00
Number of Bugs	53.33	8.16	55.56	29.40	77.78	11.11	46.67	8.16	100.00	0.00	100.00	0.00

Statistical Tests

	1995 vs. 1996			1995 vs. 1997			1995 vs. 1998			1995 vs. 1999			1995 vs. 2000		
	Δ	z	p	Δ	z	p	Δ	z	p	Δ	z	p	Δ	z	p
Total Score	1.04	0.05	.96	13.16	0.68	.50	9.67	0.72	.47	36.27	1.79	.07	41.93	5.36	<.01
Number of Conditions	34.67	1.17	.24	14.67	0.79	.43	20.00	0.87	.38	41.33	1.30	.19	28.00	1.61	.01
Access to Conditions	-18.33	-1.03	.30	15.00	0.96	.34	20.00	1.26	.21	40.00	1.55	.12	40.00	6.53	<.01
Amount of Conditions	13.33	0.40	.69	5.00	0.15	.88	15.00	0.72	.47	30.00	1.04	.30	55.00	3.77	<.01
Method of Measurement	-26.67	-1.37	.17	6.67	0.19	.85	0.00	0.00	1.00	23.33	1.20	.23	40.00	4.00	<.01
Number of Bugs	2.22	0.07	.94	24.44	1.77	.08	-6.67	-0.58	.56	46.67	5.72	<.01	46.67	5.72	<.01

Table 119
New York
Written Full Investigation
Student Means
Percent Correct by Total Score and Subscores

	Comparison (1995)		SS&C 1 (1996)		SS&C 2 (1997)		SS&C 3 (1998)		SS&C 4 (1999)		SS&C 5 (2000)	
	n = 5		n = 3		n = 4		n = 5		n = 2		n =	
	mean	s.e.	mean	s.e.	mean	s.e.	mean	s.e.	mean	s.e.	mean	s.e.
Total Score	40.00	11.49	74.89	13.75	84.58	6.02	63.27	12.03	18.33	18.33	No data for 2000	
Number of Conditions	40.00	10.95	80.00	20.00	100.00	0.00	68.00	20.59	0.00	0.00		
Access to Conditions	35.00	10.00	66.67	16.67	68.75	6.25	50.00	15.81	25.00	25.00		
Amount of Conditions	35.00	18.71	83.33	16.67	100.00	0.00	75.00	15.81	50.00	50.00		
Method of Measurement	30.00	12.25	66.67	33.33	62.50	23.94	30.00	20.00	0.00	0.00		
Number of Bugs	60.00	16.33	77.78	11.11	91.67	8.33	93.33	6.67	16.67	16.67		

Statistical Tests

	1995 vs. 1996			1995 vs. 1997			1995 vs. 1998			1995 vs. 1999			1995 vs. 2000		
	Δ	z	p	Δ	z	p	Δ	z	p	Δ	z	p	Δ	z	p
Total Score	34.89	1.95	.05	44.58	3.44	<.01	23.27	1.40	.16	-21.67	-1.00	.32	No data for 2000		
Number of Conditions	40.00	1.75	.08	60.00	5.48	<.01	28.00	1.20	.23	-40.00	-3.65	.00			
Access to Conditions	31.67	1.63	.10	33.75	2.86	<.01	15.00	0.80	.42	-10.00	-0.37	.71			
Amount of Conditions	48.33	1.93	.05	65.00	3.47	<.01	40.00	1.63	.10	15.00	0.28	.78			
Method of Measurement	36.67	1.03	.30	32.50	1.21	.23	0.00	0.00	1.00	-30.00	-2.45	.01			
Number of Bugs	17.78	0.90	.37	31.67	1.73	.08	33.33	1.89	.06	-43.33	-1.86	.06			

Table 120
Texas
Student Questionnaire
Student Means
Percent of Time Spent by Class Activities in SS&C and Comparison Classes

Activity	Comparison (1995)		SS&C 1 (1996)		SS&C 2 (1997)		SS&C 3 (1998)		SS&C 4 (1999)		SS&C 5 (2000)	
	n = 201		n = 192		n = 191		n = 157		n = 133		n = 90	
	mean	s.e.	mean	s.e.	mean	s.e	mean	s.e	mean	s.e	mean	s.e
Inquiry	31.26	0.56	28.50	0.49	29.62	0.55	31.10	0.61	32.77	0.77	32.02	0.84
Group	27.12	0.52	30.12	0.51	31.34	0.57	29.41	0.59	28.04	0.75	28.07	0.88
Traditional	20.24	0.42	20.05	0.45	20.13	0.43	20.45	0.46	20.51	0.60	20.46	0.66
Other	21.38	0.39	21.32	0.45	18.91	0.40	19.05	0.54	18.68	0.61	19.45	0.63

Statistical Tests

Activity	1995 vs. 1996			1995 vs. 1997			1995 vs. 1998			1995 vs. 1999			1995 vs. 2000		
	Δ	z	p	Δ	z	p	Δ	z	p	Δ	z	p	Δ	z	p
Inquiry	-2.76	-3.69	<.01	-1.65	-2.09	.04	-0.17	-0.20	.84	1.51	1.58	.11	0.76	0.75	.45
Group	3.00	4.13	<.01	4.22	5.48	<.01	2.28	2.91	<.01	0.92	1.01	.31	0.95	0.93	.35
Traditional	-0.19	-0.30	.76	-0.10	-0.17	.87	0.22	0.35	.73	0.27	0.37	.71	-9.78	-12.51	<.01
Other	-0.06	-0.10	.92	-2.47	-4.44	<.01	-2.34	-3.53	<.01	-2.70	-3.73	<.01	-1.93	-2.60	.01

Table 121
Texas
Student Questionnaire
Student Means
Frequency of Class Activities in SS&C and Comparison Classes

Activity	Comparison (1995)			SS&C 1 (1996)			SS&C 2 (1997)			SS&C 3 (1998)			SS&C 4 (1999)			SS&C 5 (2000)		
	mean	s.e.	n	mean	s.e.	n	mean	s.e.	n	mean	s.e.	n	mean	s.e.	n	mean	s.e.	n
Inquiry	2.94	0.07	210	3.32	0.07	210	3.42	0.08	198	3.22	0.09	157	3.08	0.10	142	3.24	0.13	98
Group	2.57	0.07	210	3.49	0.08	217	3.52	0.07	202	3.04	0.08	159	2.69	0.09	148	2.90	0.13	99
Traditional	1.97	0.06	208	2.33	0.07	211	2.36	0.07	198	2.15	0.08	159	1.96	0.08	148	2.03	0.09	99
Other	2.01	0.05	213	2.44	0.06	215	2.17	0.07	202	1.97	0.07	159	1.79	0.08	142	1.94	0.09	101

1 = Never, 2 = Less than once a week, 3 = About once a week, 4 = Several times a week, 5=Almost every day

Statistical Tests

Activity	1995 vs. 1996			1995 vs. 1997			1995 vs. 1998			1995 vs. 1999			1995 vs. 2000		
	Δ	t	p	Δ	t	p	Δ	t	p	Δ	t	p	Δ	t	p
Inquiry	0.38	3.66	<.01	0.49	4.42	<.01	0.28	2.46	.01	0.15	1.22	.22	0.31	2.24	.03
Group	0.92	9.00	<.01	0.95	9.78	<.01	0.47	4.48	<.01	0.12	1.10	.27	0.33	2.50	.01
Traditional	0.36	3.88	<.01	0.38	4.01	<.01	0.17	1.79	.07	-0.02	-0.16	.88	0.05	0.49	.62
Other	0.43	5.40	<.01	0.15	1.83	.07	-0.04	-0.45	.65	-0.22	-2.45	.02	-0.07	-0.73	.47

Table 22
Texas
Student Questionnaire
Student Means
Frequency of Inquiry Class Activities

Activity	Comparison (1995)		SS&C 1 (1996)		SS&C 2 (1997)		SS&C 3 (1998)		SS&C 4 (1999)		SS&C 5 (2000)	
	n = 210		n = 210		n = 198		n = 157		n = 142		n = 98	
	mean	s.e.	mean	s.e.	mean	s.e	mean	s.e	mean	s.e	mean	s.e
Total (Combined Inquiry)	2.94	0.07	3.32	0.07	3.42	0.08	3.22	0.09	3.08	0.10	3.24	0.13
Demonstration of a scientific principle	3.06	0.09	3.38	0.09	3.49	0.09	3.41	0.10	3.42	0.11	3.58	0.14
Ask students to suggest hypotheses	2.72	0.10	3.10	0.09	3.30	0.10	3.05	0.11	2.79	0.12	2.95	0.15
Ask students to interpret data	2.79	0.09	3.39	0.09	3.33	0.10	3.08	0.11	3.01	0.12	3.11	0.15
Relate previous work to current topic	3.19	0.09	3.38	0.09	3.50	0.10	3.30	0.11	3.18	0.12	3.36	0.14

1 = Never, 2 = Less than once a week, 3 = About once a week, 4 = Several times a week, 5 = Almost every day

Statistical Tests

Activity	1995 vs. 1996			1995 vs. 1997			1995 vs. 1998			1995 vs. 1999			1995 vs. 2000		
	Δ	t	p	Δ	t	p	Δ	t	p	Δ	t	p	Δ	t	p
Total (Combined Inquiry)	0.38	3.66	<.01	0.49	4.42	<.01	0.28	2.46	.01	0.15	1.22	.22	0.31	2.24	.03
Demonstration of a scientific principle	0.32	2.59	.01	0.43	3.35	<.01	0.35	2.57	.01	0.36	2.55	.01	0.52	3.27	<.01
Ask students to suggest hypotheses	0.38	2.84	<.01	0.59	4.19	<.01	0.33	2.26	.03	0.07	0.46	.64	0.23	1.34	.18
Ask students to interpret data	0.60	4.58	<.01	0.54	3.97	<.01	0.29	1.99	.05	0.22	1.41	.16	0.32	1.84	.07
Relate previous work to current topic	0.19	1.53	.13	0.32	2.38	.02	0.11	0.80	.43	-0.01	-0.07	.94	0.17	1.07	.29

Table 123
Texas
Student Questionnaire
Student Means
Frequency of Group Class Activities

Activity	Comparison (1995)		SS&C 1 (1996)		SS&C 2 (1997)		SS&C 3 (1998)		SS&C 4 (1999)		SS&C 5 (2000)	
	n = 210		n = 217		n = 202		n = 159		n = 148		n = 99	
	mean	s.e.	mean	s.e.	mean	s.e	mean	s.e	mean	s.e	mean	s.e
Total (Combined Group)	2.57	0.07	3.49	0.08	3.52	0.07	3.04	0.08	2.69	0.09	2.90	0.13
Do experiments with other students	2.38	0.08	3.33	0.09	3.25	0.09	2.56	0.09	2.41	0.10	2.67	0.14
Work in groups	2.83	0.10	3.76	0.09	3.90	0.09	3.47	0.11	3.03	0.12	3.18	0.15
Share results from experiments	2.53	0.09	3.42	0.09	3.42	0.09	3.12	0.11	2.65	0.12	2.85	.15

1 = Never, 2 = Less than once a week, 3 = About once a week, 4 = Several times a week, 5 = Almost every day

Statistical Tests

Activity	1995 vs. 1996			1995 vs. 1997			1995 vs. 1998			1995 vs. 1999			1995 vs. 2000		
	Δ	t	p	Δ	t	p	Δ	t	p	Δ	t	p	Δ	t	p
Total (Combined Group)	0.92	9.00	<.01	0.95	9.78	<.01	0.47	4.48	<.01	0.12	1.10	.27	0.33	2.50	.01
Do experiments with other students	0.95	8.13	<.01	0.87	7.50	<.01	0.18	1.50	.14	0.02	0.20	.84	0.29	1.99	.05
Work in groups	0.92	6.96	<.01	1.07	8.15	<.01	0.63	4.41	<.01	0.20	1.31	.19	0.34	1.97	.05
Share results from experiments	0.89	6.79	<.01	0.90	7.03	<.01	0.59	4.27	<.01	0.12	0.86	.39	0.32	1.93	.05

Table 124
Texas
Student Questionnaire
Student Means
Frequency of Traditional Class Activities

Activity	Comparison (1995)		SS&C 1 (1996)		SS&C 2 (1997)		SS&C 3 (1998)		SS&C 4 (1999)		SS&C 5 (2000)	
	n = 208		n = 211		n = 198		n = 159		n = 148		n = 99	
	mean	s.e.	mean	s.e	mean	s.e	mean	s.e	mean	s.e	mean	s.e
Total (Combined Traditional)	1.97	0.06	2.33	0.07	2.36	0.07	2.15	0.08	1.96	0.08	2.03	0.09
Read articles on science	1.98	0.08	2.11	0.08	2.24	0.09	2.14	0.09	1.83	0.09	1.77	0.11
Do oral or written reports	1.71	0.07	2.20	0.09	2.22	0.09	1.87	0.09	1.80	0.10	2.09	0.11
Read other science materials	2.21	0.09	2.68	0.09	2.63	0.10	2.45	0.11	2.23	0.11	2.26	0.14

1 = Never, 2 = Less than once a week, 3 = About once a week, 4 = Several times a week, 5 = Almost every day

Statistical Tests

Activity	1995 vs. 1996			1995 vs. 1997			1995 vs. 1998			1995 vs. 1999			1995 vs. 2000		
	Δ	t	p	Δ	t	p	Δ	t	p	Δ	t	p	Δ	t	p
Total (Combined Traditional)	0.36	3.88	<.01	0.38	4.01	<.01	0.17	1.79	.07	-0.02	-0.16	.88	0.05	0.49	.62
Read articles on science	0.13	1.14	.26	0.26	2.19	.03	0.17	1.36	.18	-0.15	-1.18	.24	-0.21	-1.49	.14
Do oral or written reports	0.49	4.39	<.01	0.51	4.44	<.01	0.15	1.35	.18	0.08	0.72	.47	0.37	2.94	<.01
Read other science materials	0.48	3.66	<.01	0.42	3.12	<.01	0.24	1.70	.09	0.05	0.35	.73	0.05	0.30	.76

Table 125
Texas
Student Questionnaire
Student Means
Frequency of Other Class Activities

Activity	Comparison (1995)		SS&C 1 (1996)		SS&C 2 (1997)		SS&C 3 (1998)		SS&C 4 (1999)		SS&C 5 (2000)	
	n = 213		n = 215		n = 202		n = 159		n = 142		n = 101	
	mean	s.e.	mean	s.e	mean	s.e	mean	s.e	mean	s.e	mean	s.e
Total (Combined Other)	2.01	0.05	2.44	0.06	2.17	0.07	1.97	0.07	1.79	0.08	1.94	0.09
Watch films, slides, or videos	2.54	0.07	2.97	0.08	2.49	0.08	2.25	0.10	1.90	0.10	2.46	0.12
Go outside for class instruction	1.48	0.07	1.93	0.08	1.83	0.09	1.70	0.08	1.68	0.09	1.43	0.10

1 = Never, 2 = Less than once a week, 3 = About once a week, 4 = Several times a week, 5 = Almost every day

Statistical Tests

Activity	1995 vs. 1996			1995 vs. 1997			1995 vs. 1998			1995 vs. 1999			1995 vs. 2000		
	Δ	t	p	Δ	t	p	Δ	t	p	Δ	t	p	Δ	t	p
Total (Combined Other)	0.43	5.40	<.01	0.15	1.83	.07	-0.04	-0.45	.65	-0.22	-2.45	.02	-0.07	-0.73	.47
Watch films, slides, or videos	0.43	4.08	<.01	-0.06	-0.54	.59	-0.30	-2.56	.01	-0.64	-5.47	<.01	-0.08	-0.64	.53
Go outside for class instruction	0.45	4.32	<.01	0.35	3.32	<.01	0.22	2.14	.03	0.20	1.84	.07	-0.05	-0.40	.69

Table 126
Texas
Teacher Questionnaire
Individual Means
Frequency of Class Activities

Activity	**Comparison (1995)**		**SS&C 1 (1996)**		**SS&C 2 (1997)**		**SS&C 3 (1998)**		**SS&C 4 (1999)**		**SS&C 5 (2000)**	
	n = 4		n = 5		n = 3		n = 4		n = 4		n = 3	
	mean	s.e.	mean	s.e.	mean	s.e.	mean	s.e.	mean	s.e.	mean	s.e.
Inquiry	3.56	0.44	4.36	0.23	4.08	0.08	3.69	0.43	3.50	0.18	3.67	0.22
Traditional	2.88	0.66	3.13	0.66	2.78	0.40	3.08	0.21	2.42	0.32	2.78	0.40

1 = Never, 2 = Less than once a week, 3 = About once a week, 4 = Several times a week, 5 = Almost every day

Statistical Tests

Activity	**1995 vs. 1996**			**1995 vs. 1997**			**1995 vs. 1998**			**1995 vs. 1999**			**1995 vs. 2000**		
	Δ	t	p	Δ	t	p	Δ	t	p	Δ	t	p	Δ	t	p
Inquiry	0.79	1.69	.14	0.52	1.00	.36	0.13	0.21	.84	-0.06	-0.13	.90	0.10	0.19	.86
Traditional	0.26	0.27	.79	-0.10	-0.12	.91	0.21	0.30	.77	-0.46	-0.63	.55	-0.10	-0.12	.91

Table 127
Texas
Teacher Questionnaire
Individual Means
Frequency of Inquiry Class Activities

Activity	Comparison (1995)		SS&C 1 (1996)		SS&C 2 (1997)		SS&C 3 (1998)		SS&C 4 (1999)		SS&C 5 (2000)	
	n = 4		n = 5		n = 3		n = 4		n = 4		n = 3	
	mean	s.e.	mean	s.e.	mean	s.e.	mean	s.e.	mean	s.e.	mean	s.e.
Total (Combined Inquiry)	3.56	0.44	4.36	0.23	4.08	0.08	3.69	0.43	3.50	0.18	3.67	0.22
Do experiments	2.75	0.25	4.20	0.37	4.33	0.33	3.25	0.48	3.00	0.41	2.67	0.88
Ask for reasons for the results of experiments	4.00	0.71	4.80	0.20	4.00	0.00	3.50	0.50	3.75	0.25	4.00	0.00
Ask students to suggest hypotheses	3.50	0.65	3.80	0.58	3.67	0.33	3.50	0.87	3.50	0.50	4.00	0.00
Ask students to interpret data	4.00	0.41	4.60	0.24	4.33	0.33	4.50	0.29	3.75	0.25	4.00	0.00

1 = Never, 2 = Less than once a week, 3 = About once a week, 4 = Several times a week, 5 = Almost every day

Statistical Tests

Activity	1995 vs. 1996			1995 vs. 1997			1995 vs. 1998			1995 vs. 1999			1995 vs. 2000		
	Δ	t	p	Δ	t	p	Δ	t	p	Δ	t	p	Δ	t	p
Total (Combined Inquiry)	0.79	1.69	.14	0.52	1.00	.36	0.13	0.21	.84	-0.06	-0.13	.90	0.10	0.19	.86
Do experiments	1.45	3.04	.02	1.58	3.90	.01	0.50	0.93	.39	0.25	0.52	.62	-0.08	-0.11	.92
Ask for reasons for the results of experiments	0.80	1.21	.27	0.00	0.00	1.00	-0.50	-0.58	.59	-0.25	-0.33	.75	0.00	0.00	1.00
Ask students to suggest hypotheses	0.30	0.34	.74	0.17	0.21	.85	0.00	0.00	1.00	0.00	0.00	1.00	0.50	0.66	.54
Ask students to interpret data	0.60	1.32	.23	0.33	0.60	.58	0.50	1.00	.36	-0.25	-0.52	.62	0.00	0.00	1.00

Table 128
Texas
Teacher Questionnaire
Individual Means
Frequency of Traditional Class Activities

Activity	Comparison (1995)		SS&C 1 (1996)		SS&C 2 (1997)		SS&C 3 (1998)		SS&C 4 (1999)		SS&C 5 (2000)	
	n = 4		n = 5		n = 3		n = 4		n = 4		n = 3	
	mean	s.e.	mean	s.e.	mean	s.e.	mean	s.e.	mean	s.e.	mean	s.e.
Total (Combined Traditional)	2.88	0.66	3.13	0.66	2.78	0.40	3.08	0.21	2.42	0.32	2.78	0.40
Read articles on science	2.75	0.63	3.80	0.49	3.00	0.58	3.50	0.29	2.25	0.25	2.67	0.33
Do oral or written reports	2.75	0.75	2.60	0.81	3.00	0.58	2.50	0.29	2.25	0.25	2.33	0.33
Read other science materials	3.67	0.67	3.00	0.84	2.33	0.33	3.25	0.48	2.75	0.48	3.33	0.67

1 = Never, 2 = Less than once a week, 3 = About once a week, 4 = Several times a week, 5 = Almost every day

Statistical Tests

Activity	1995 vs. 1996			1995 vs. 1997			1995 vs. 1998			1995 vs. 1999			1995 vs. 2000		
	Δ	t	p	Δ	t	p	Δ	t	p	Δ	t	p	Δ	t	p
Total (Combined Traditional)	0.26	0.27	.79	-0.10	-0.12	.91	0.21	0.30	.77	-0.46	-0.63	.55	-0.10	-0.12	.91
Read articles on science	1.05	1.34	.22	0.25	0.28	.79	0.75	1.08	.32	-0.50	-0.74	.49	-0.08	-0.11	.92
Do oral or written reports	-0.15	-0.13	.90	0.25	0.24	.81	-0.25	-0.31	.77	-0.50	-0.63	.55	-0.42	-0.45	.67
Read other science materials	-0.67	-0.55	.60	-1.33	-1.79	.15	-0.42	-0.52	.62	-0.92	-1.15	.30	-0.33	-0.35	.74

Table 129
Texas
Classroom Observations
Percent Time Spent by Teaching Style

Style	Comparison (1995)		SS&C 1 (1996)		SS&C 2 (1997)		SS&C 3 (1998)		SS&C 4 (1999)		SS&C 5 (2000)	
	n = 7		n = 7		n = 3		n = 8		n = 6		n = 3	
	freq.	%	freq.	%	freq.	%	freq.	%	freq.	%	freq.	%
Teacher-Centered	63	77.78	18	24.32	5	17.86	36	61.02	15	23.44	11	35.48
Student- & Teacher-Centered	4	4.94	9	12.16	12	42.86	20	33.90	20	31.25	13	41.94
Student-Centered	6	7.41	28	37.84	11	39.29	0	0.00	24	37.50	4	12.90
Administrative	6	7.41	14	18.92	0	0.00	3	5.08	5	7.81	2	6.45
Other activities	2	2.47	5	6.76	0	0.00	0	0.00	0	0.00	1	3.23

Statistical Tests

Style	1995 vs. 1996		1995 vs. 1997		1995 vs. 1998		1995 vs. 1999		1995 vs. 2000	
	χ^2	p	χ^2	p	χ^2	p	χ^2	p	χ^2	p
Teacher-Centered										
Student- & Teacher-Centered										
Student-Centered										
Administrative										
Other activities										
	45.76	<.01	48.51	<.01	24.01	<.01	52.00	<.01	29.96	<.01

χ^2 critical values: At .05 = 9.49; at .025 = 11.14; at .01 = 13.28

Table 130
Texas
Classroom Observations
Frequency of Student Involvement and Type of Instruction

Variable *Response*	Comparison (1995)		SS&C 1 (1996)		SS&C 2 (1997)		SS&C 3 (1998)		SS&C 4 (1999)		SS&C 5 (2000)	
	n = 7		n = 7		n = 3		n = 8		n = 6		n = 3	
	freq.	%	freq.	%	freq.	%	freq.	%	freq.	%	freq.	%
Student Involvement												
Almost always	4	57.1	4	57.1	0	0.0	2	25.0	1	16.7	0	0.0
Sometimes	3	42.9	2	28.6	3	100.0	6	75.0	5	83.3	3	100.0
Almost never	0	0.0	1	14.3	0	0.0	0	0.0	0	0.0	0	0.0
Type of Instruction												
Traditional	7	100.0	7	100.0	3	100.0	8	100.0	6	100.0	3	100.0
Mixed	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Inquiry	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0

Statistical Tests

Variable	1995 vs. 1996		1995 vs. 1997		1995 vs. 1998		1995 vs. 1999		1995 vs. 2000	
	χ^2	p	χ^2	p	χ^2	p	χ^2	p	χ^2	p
Student Involvement	1.20	.55	2.86	.09	1.61	.21	2.24	.14	2.86	.09
Type of Instruction	Can't be calculated*		Can't be calculated*		Can't be calculated*		Can't be calculated*		Can't be calculated*	

* The chi-square statistic is not calculated because at least one of the variables is a constant.

Table 131
Texas
Curriculum Verification
Number of Weeks Spent on Science Topics

Standard	Comparison (1995)		SS&C 1 (1996)		SS&C 2 (1997)		SS&C 3 (1998)		SS&C 4 (1999)*		SS&C 5 (2000)*	
	classes affected = 21		classes affected = 24		classes affected = 27		classes affected = 21		classes affected = 21		classes affected = 14	
	weeks	%	weeks	%	weeks	%	weeks	%	weeks	%	weeks	%
Chemistry	16.0	49.23	7.0	21.21	7.0	18.92	15.0	41.55	18.0	50.00	18.0	50.00
Biology	0.0	0.00	9.0	27.27	11.0	29.73	8.6	23.82	0.0	0.00	0.0	0.00
Earth & Space Sciences	0.0	0.00	10.0	30.30	6.0	16.22	3.0	8.31	0.0	0.00	0.0	0.00
Physics	15.5	47.69	7.0	21.21	10.0	27.03	8.0	22.16	16.0	44.44	16.0	44.44
Measurement	1.0	3.08	0.0	0.00	2.0	5.41	0.0	0.00	1.0	2.78	1.0	2.78
Science & Society	0.0	0.00	0.0	0.00	1.0	2.70	1.5	4.16	1.0	2.78	1.0	2.78
Miscellaneous	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00

* The same data were submitted for both years

Table 132
Texas
Learning Environment Inventory
Student Means

Subscale	Comparison (1995)		SS&C 1 (1996)		SS&C 2 (1997)		SS&C 3 (1998)		SS&C 4 (1999)		SS&C 5 (2000)	
	n = 215		n = 245		n = 222		n = 165		n = 156		n = 103	
	mean	s.e.	mean	s.e.	mean	s.e.	mean	s.e.	mean	s.e.	mean	s.e.
Difficulty	2.77	0.05	2.69	0.04	2.77	0.04	2.66	0.05	2.75	0.05	2.80	0.06
Relevance	3.25	0.05	3.38	0.04	3.49	0.05	3.51	0.05	3.50	0.05	3.50	0.06
Critical Voice	3.64	0.05	3.77	0.04	3.71	0.05	3.80	0.05	3.89	0.06	3.75	0.07
Involvement	3.41	0.05	3.68	0.05	3.68	0.05	3.64	0.05	3.75	0.05	3.58	0.07
Sequencing	2.46	0.06	2.20	0.05	2.17	0.05	2.31	0.07	2.30	0.08	2.21	0.08
Experimenting	2.28	0.05	2.61	0.05	2.51	0.06	2.56	0.06	2.41	0.07	2.36	0.07

1 = Almost Never, 2 = Seldom, 3 = Sometimes, 4 = Often, 5 = Almost Always

Statistical Tests

Subscale	1995 vs. 1996			1995 vs. 1997			1995 vs. 1998			1995 vs. 1999			1995 vs. 2000		
	Δ	t	p	Δ	t	p	Δ	t	p	Δ	t	p	Δ	t	p
Difficulty	-0.08	-1.32	.19	0.05	0.08	.94	-0.11	-1.56	.12	-0.02	-0.23	.82	0.03	0.38	.71
Relevance	0.13	2.02	.04	0.24	3.69	<.01	0.25	3.69	<.01	0.25	3.61	<.01	0.25	3.08	<.01
Critical Voice	0.12	1.82	.07	0.07	0.93	.35	0.16	2.10	.04	0.25	3.17	<.01	0.10	1.16	.25
Involvement	0.26	4.05	<.01	0.27	4.08	<.01	0.22	3.22	<.01	0.34	4.81	<.01	0.17	2.03	.04
Sequencing	-0.26	-3.30	<.01	-0.29	-3.60	<.01	-0.15	-1.67	.10	-0.16	-1.69	.09	-0.25	-2.42	.02
Experimenting	0.34	4.45	<.01	0.23	2.98	<.01	0.28	3.39	<.01	0.13	1.54	.12	0.08	0.90	.37

Table 133
Texas
Student Questionnaire
Student Means
Inclination to Continue Studying Science
Percentage of Students who Responded "YES"

Item	Comparison (1995)		SS&C 1 (1996)		SS&C 2 (1997)		SS&C 3 (1998)		SS&C 4 (1999)		SS&C 5 (2000)	
	n = 201		n = 223		n = 190		n = 157		n = 148		n = 100	
	mean	s.e.	mean	s.e..	mean	s.e.	mean	s.e.	mean	s.e.	mean	s.e.
Take a science class in 10th grade	89.47	2.13	93.72	1.57	96.12	1.35	95.60	1.63	90.13	2.43	89.22	3.09
Take a science class in 11th grade	82.69	2.63	87.01	2.22	84.73	2.53	87.50	2.62	82.67	3.10	87.25	3.32
Take a science class in 12th grade	62.50	3.36	65.22	3.15	66.33	3.38	80.00	3.17	73.65	3.63	69.31	4.61
Take a science class in college	61.17	3.40	69.00	3.06	68.56	3.34	63.52	3.83	64.90	3.90	59.00	4.94

Statistical Tests

Item	1995 vs. 1996			1995 vs. 1997			1995 vs. 1998			1995 vs. 1999			1995 vs. 2000		
	Δ	z	p	Δ	z	p	Δ	z	p	Δ	z	p	Δ	z	p
Take a science class in 10th grade	4.25	1.61	.11	6.65	2.64	.01	6.13	2.29	.02	0.66	0.20	.84	-0.25	-0.07	.94
Take a science class in 11th grade	4.32	1.26	.21	2.04	0.56	.58	4.81	1.30	.19	-0.02	-0.00	.99	4.56	1.08	.28
Take a science class in 12th grade	2.72	0.59	.56	3.83	0.80	.42	17.50	3.79	<.01	11.15	2.25	.02	6.81	1.19	.23
Take a science class in college	7.83	1.58	.11	7.39	1.55	.12	2.35	0.46	.65	3.73	0.72	.47	-2.17	-0.36	.72

Table 134
Texas
Student Questionnaire
Student Means
Science Motivation
Percentage of Students who Responded "YES"

Item	Comparison (1995)		SS&C 1 (1996)		SS&C 2 (1997)		SS&C 3 (1998)		SS&C 4 (1999)		SS&C 5 (2000)	
	n = 204		n = 228		n = 196		n = 156		n = 148		n = 98	
	mean	s.e.	mean	s.e.	mean	s.e.	mean	s.e.	mean	s.e.	mean	s.e.
Do you think you will pursue a career in science?	22.38	2.88	32.07	3.04	30.20	3.24	23.12	3.34	25.49	3.53	25.00	4.35
Have activities in science class made you want to take more science?	30.00	3.17	53.62	3.26	51.69	3.48	38.89	3.84	39.22	3.96	34.31	4.72
Is your science class motivating?	47.60	3.47	65.37	3.14	66.34	3.33	59.75	3.90	62.25	3.96	60.78	4.86
Have you ever had a "totally awesome" experience in your science class?	40.76	3.39	70.64	2.98	64.25	3.34	59.88	3.86	45.10	4.04	46.60	4.94

Statistical Tests

Item	1995 vs. 1996			1995 vs. 1997			1995 vs. 1998			1995 vs. 1999			1995 vs. 2000		
	Δ	z	p	Δ	z	p	Δ	z	p	Δ	z	p	Δ	z	p
Do you think you will pursue a career in science?	9.69	2.31	.02	7.82	1.80	.07	0.74	0.17	.87	3.11	0.68	.50	2.62	0.50	.62
Have activities in science class made you want to take more science?	23.62	5.19	<.01	21.69	4.61	<.01	8.89	1.79	.07	9.22	1.82	.07	4.31	0.76	.45
Is your science class motivating?	17.77	3.80	<.01	18.74	3.90	<.01	12.15	2.33	.02	14.65	2.78	.01	13.18	2.21	.03
Have you ever had a "totally awesome" experience in your science class?	29.88	6.62	<.01	23.49	4.94	<.01	19.12	3.72	<.01	4.34	0.82	.41	5.84	0.97	.33

Table 135 - Texas
Student Questionnaire - Student Means - Students' Attitudes toward Science

Item	Comparison (1995)		SS&C 1 (1996)		SS&C 2 (1997)		SS&C 3 (1998)		SS&C 4 (1999)		SS&C 5 (2000)	
	n = 210		n = 222		n = 203		n = 161		n = 150		n = 102	
	mean	s.e.	mean	s.e.	mean	s.e.	mean	s.e.	mean	s.e.	mean	s.e.
Science is useful to me outside of class.	3.10	0.08	3.32	0.08	3.24	0.09	3.28	0.10	3.14	0.10	3.48	0.11
The things you learn in science relate to the real world.	3.58	0.08	3.59	0.08	3.81	0.08	3.88	0.09	3.69	0.10	3.79	0.12
Much of what you learn in science classes will be useful in the future.	3.74	0.08	3.96	0.07	3.96	0.08	3.98	0.08	3.94	0.08	3.85	0.12
It is important to know some science in order to get a good job.	3.44	0.08	3.62	0.07	3.57	0.08	3.56	0.09	3.50	0.09	3.64	0.10
Science class is interesting.	2.84	0.08	3.28	0.07	3.30	0.08	3.13	0.09	3.08	0.10	2.97	0.12
Science class is fun.	2.85	0.08	3.49	0.08	3.44	0.08	3.25	0.09	3.26	0.09	3.00	0.12

1 = Strongly Disagree, 2 = Disagree, 3 = No Opinion, 4 = Agree, 5 = Strongly Agree

Statistical Tests

Item	1995 vs. 1996			1995 vs. 1997			1995 vs. 1998			1995 vs. 1999			1995 vs. 2000		
	Δ	t	p	Δ	t	p	Δ	t	p	Δ	t	p	Δ	t	p
Science is useful to me outside of class.	0.22	1.96	.05	0.14	1.13	.26	0.18	1.40	.16	0.04	0.28	.78	0.38	2.65	<.01
The things you learn in science relate to the real world.	0.02	0.15	.88	0.23	2.01	.05	0.31	2.52	.01	0.11	0.90	.37	0.21	1.47	.14
Much of what you learn in science classes will be useful in the future.	0.22	2.17	.03	0.22	1.93	.06	0.24	2.10	.04	0.20	1.82	.07	0.12	0.86	.39
It is important to know some science in order to get a good job.	0.18	1.75	.08	0.13	1.19	.24	0.12	0.97	.33	0.06	0.55	.58	0.20	1.50	.13
Science class is interesting.	0.44	3.94	<.01	0.46	3.98	<.01	0.29	2.36	.02	0.24	1.85	.07	0.13	0.89	.38
Science class is fun.	0.64	5.75	<.01	0.59	5.24	<.01	0.40	3.24	<.01	0.41	3.31	<.01	0.15	1.05	.30

Table 136
Texas
Student Questionnaire
Student Means
Percent of Students Who Have Participated in Science Activities Outside of Class

Activity	Comparison (1995)		SS&C 1 (1996)		SS&C 2 (1997)		SS&C 3 (1998)		SS&C 4 (1999)		SS&C 5 (2000)	
	n = 206		n = 235		n = 206		n = 161		n = 155		n = 102	
	mean	s.e.	mean	s.e.	mean	s.e.	mean	s.e.	mean	s.e.	mean	s.e.
Talk about what you learn in science class	37.74	3.34	56.67	3.21	53.08	3.44	44.17	3.90	40.76	3.93	42.72	4.90
Watch a science program on TV	47.17	3.44	57.50	3.20	57.89	3.42	60.74	3.84	51.28	4.01	44.12	4.94
Go bird watching	8.49	1.92	14.58	2.28	11.43	2.20	14.72	2.78	12.74	2.67	6.80	2.49
Go to a science museum	44.86	3.41	48.12	3.24	49.05	3.46	49.69	3.93	45.22	3.98	49.51	4.95
Talk about science topics	28.64	3.10	41.25	3.18	45.45	3.45	42.33	3.88	35.26	3.84	38.83	4.83

Statistical Tests

Activity	1995 vs. 1996			1995 vs. 1997			1995 vs. 1998			1995 vs. 1999			1995 vs. 2000		
	Δ	z	p	Δ	z	p	Δ	z	p	Δ	z	p	Δ	z	p
Talk about what you learn in science class	18.93	4.09	<.01	15.34	3.20	<.01	6.43	1.25	.21	3.02	0.59	.56	4.98	0.84	.40
Watch a science program on TV	10.33	2.20	.03	10.72	2.21	.03	13.57	2.63	.01	4.11	0.78	.44	-3.05	-0.51	.61
Go bird watching	6.09	2.04	.04	2.94	1.01	.31	6.23	1.84	.07	4.25	1.29	.20	-1.69	-0.54	.59
Go to a science museum	3.26	0.69	.49	4.19	0.86	.39	4.83	0.93	.35	0.36	0.07	.94	4.65	0.77	.44
Talk about science topics	12.61	2.84	<.01	16.82	3.62	<.01	13.69	2.76	.01	6.62	1.34	.18	10.19	1.78	.08

Table 137 – Texas: Student Questionnaire
Percent of Students Who Have Participated in Science Activities Outside of Class (continued)

Activity	Comparison (1995)		SS&C 1 (1996)		SS&C 2 (1997)		SS&C 3 (1998)		SS&C 4 (1999)		SS&C 5 (2000)	
	n = 206		n = 235		n = 206		n = 161		n = 155		n = 102	
	mean	s.e.	mean	s.e.	mean	s.e.	mean	s.e.	mean	s.e.	mean	s.e.
Build a telescope	5.63	1.58	5.00	1.41	6.19	1.67	5.52	1.79	3.21	1.41	1.94	1.37
Read books about science	44.60	3.41	51.46	3.24	46.67	3.45	45.06	3.92	37.58	3.88	44.66	4.92
Do a science experiment	39.81	3.38	63.18	3.13	59.05	3.40	57.41	3.90	46.50	3.99	57.28	4.90
Write an article for a science journal	7.55	1.82	13.81	3.24	9.09	1.99	7.98	2.13	11.46	2.55	13.59	3.39
Read a science magazine	41.31	3.38	38.91	3.16	39.52	3.38	46.01	3.92	38.22	3.89	35.92	4.75

Statistical Tests

Activity	1995 vs. 1996			1995 vs. 1997			1995 vs. 1998			1995 vs. 1999			1995 vs. 2000		
	Δ	z	p	Δ	z	p	Δ	z	p	Δ	z	p	Δ	z	p
Build a telescope	-0.63	-0.30	.76	0.56	0.24	.81	-0.11	-0.05	.96	-2.42	-1.14	.25	--3.69	-1.76	.08
Read books about science	6.86	1.46	.14	2.07	0.43	.67	0.46	0.09	.93	-7.02	-1.36	.17	0.06	0.01	.99
Do a science experiment	23.37	5.07	<.01	19.24	4.01	<.01	17.60	3.41	<.01	6.69	1.28	.20	17.47	2.93	<.01
Write an article for a science journal	6.26	2.17	.03	1.54	0.57	.57	0.43	0.15	.88	3.91	1.25	.21	6.04	1.57	.12
Read a science magazine	-2.40	-0.52	.60	-1.79	-0.37	.71	4.70	0.91	.37	-3.09	-0.60	.55	-5.39	-0.92	.36

Table 138
Texas
Teacher Questionnaire
Individual Means
Percent Time Spent in Individual Class Activities

Activity	SS&C 3 (1998)		SS&C 4 (1999)		SS&C 5 (2000)	
	n = 4		n = 4		n = 3	
	mean	s.e.	mean	s.e.	mean	s.e.
Individual Activities (Total)	20.00	11.37	37.50	8.54	46.67	21.67
Hands-on activities	26.25	9.21	26.25	6.88	28.33	11.67
Lab write-ups	23.75	13.13	17.50	8.29	16.33	11.33
Textbook seat reading	18.75	8.75	11.25	3.15	20.00	15.00
Other reading seat work	11.00	4.93	13.75	5.54	10.00	5.00
Worksheet work	14.00	8.86	11.25	3.15	10.00	5.00
Journaling	3.75	2.39	7.50	1.44	5.00	2.89
Computer work	1.25	1.25	2.50	1.44	2.00	1.53
Other	0.00	0.00	10.00	6.77	8.33	8.33

Table 139
Texas
Teacher Questionnaire
Individual Means
Percent Time Spent in Group Activities

Activity	SS&C 3 (1998)		SS&C 4 (1999)		SS&C 5 (2000)	
	n = 4		n = 4		n = 3	
	mean	s.e.	mean	s.e.	mean	s.e.
Group Activities (Total)	37.50	12.50	47.50	4.79	37.33	15.77
Hands-on activity	26.25	9.21	31.25	7.74	35.00	7.64
Small group discussion	32.50	5.95	28.75	11.61	21.67	9.28
Lab write-ups	16.25	5.15	22.50	6.29	18.33	10.93
Worksheet work	18.75	8.75	12.50	3.23	20.00	12.58
Other	6.25	6.25	2.50	1.44	5.00	2.89

Table 140
Texas
Teacher Questionnaire
Individual Means
Percent Time Spent in Whole Class Activities

Activity	SS&C 3 (1998)		SS&C 4 (1999)		SS&C 5 (2000)	
	n = 4		n = 4		n = 3	
	mean	s.e.	mean	s.e.	mean	s.e.
Whole Class Activities (Total)	42.50	12.67	17.50	2.50	16.00	7.02
Lecture	21.25	3.75	15.00	8.66	21.67	10.14
Class discussion	40.00	9.57	42.50	8.54	45.00	13.23
Demonstration	38.75	9.66	42.50	10.31	33.33	4.41

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Table 141
Texas
Achievement Scores
Percent Correct on Achievement Tests

Test	Comparison (1995)			SS&C 1 (1996)			SS&C 2 (1997)			SS&C 3 (1998)			SS&C 4 (1999)			SS&C 5 (2000)		
	mean	s.e.	n	mean	s.e.	n	mean	s.e.	n	mean	s.e.	n	mean	s.e.	n	mean	s.e.	n
Performance Test	40.61	3.18	10	50.47	3.30	16	42.93	5.31	12	50.20	3.19	28	47.02	2.83	26	50.28	3.96	19
Science Literacy Multiple Choice	42.22	0.73	216	43.85	1.04	158	37.08	0.80	162	42.54	0.94	142	37.55	1.39	55	33.22	1.19	71
Hands-On Full Investigation	53.11	10.81	6	61.73	1.85	5	61.17	9.52	6	62.62	7.52	7	73.13	6.02	8	72.40	6.22	5
Written Full Investigation	36.67	36.67	2	12.80	7.14	5	70.42	10.61	4	37.95	7.95	7	5.80	5.80	5	2.22	2.22	3
Science Literacy Open-Ended	20.08	1.04	215	21.08	4.05	17	16.18	2.81	17	22.78	2.65	30	9.55	1.28	89	10.19	2.37	27

Statistical Tests

Test	1995 vs. 1996			1995 vs. 1997			1995 vs. 1998			1995 vs. 1999			1995 vs. 2000		
	Δ	z	p	Δ	z	p	Δ	z	p	Δ	z	p	Δ	z	p
Performance Test	9.87	2.15	.03	2.32	0.38	.70	9.59	2.13	.03	6.41	1.51	.13	9.67	1.91	.06
Science Literacy Multiple Choice	1.63	1.29	.20	-5.15	-4.75	<.01	0.31	0.26	.79	-4.68	-2.98	<.01	-9.00	-6.45	<.01
Hands-On Full Investigation	8.62	0.79	.43	8.06	0.56	.58	9.51	0.72	.47	20.01	1.62	.11	19.29	1.55	.12
Written Full Investigation	-23.87	-0.64	.52	33.75	0.88	.38	1.29	0.03	.98	-30.87	-0.83	.41	-34.45	-0.94	.35
Science Literacy Open-Ended	1.00	0.24	.81	-3.90	-1.30	.19	2.70	0.95	.34	-10.53	-6.37	<.01	-9.89	-3.82	<.01

Table 142
Texas
Lab Skills Performance Test
Student Means
Percent Correct by Total Score and Station

Station	Comparison (1995)		SS&C 1 (1996)		SS&C 2 (1997)		SS&C 3 (1998)		SS&C 4 (1999)		SS&C 5 (2000)	
	n = 10		n = 16		n = 12		n = 28		n = 26		n = 19	
	mean	s.e.	mean	s.e.	mean	s.e.	mean	s.e.	mean	s.e.	mean	s.e.
Total Score	40.61	3.18	50.47	3.30	42.93	5.31	50.20	3.19	47.02	2.83	50.28	3.96
Density	39.27	5.39	44.40	5.67	31.34	6.40	36.90	4.37	32.57	4.01	32.24	5.74
Sugar & Starch Indicators	29.63	6.70	37.09	5.26	40.43	7.28	45.24	4.64	32.34	5.04	49.95	7.37
Microscope	61.67	7.26	56.77	6.86	46.53	6.28	68.15	4.98	50.00	4.96	49.56	6.13
Rock Identification	41.39	7.54	63.72	6.21	52.55	8.54	62.70	5.69	70.94	5.05	65.50	6.39
Instruments	52.67	5.83	57.92	4.38	47.22	5.77	50.71	3.79	52.31	2.36	52.63	6.16

Statistical Tests

Station	1995 vs. 1996			1995 vs. 1997			1995 vs. 1998			1995 vs. 1999			1995 vs. 2000		
	Δ	z	p	Δ	z	p	Δ	z	p	Δ	z	p	Δ	z	p
Total Score	9.87	2.15	.03	2.32	0.38	.70	9.59	2.13	.03	6.41	1.51	.13	9.67	1.91	.06
Density	5.13	0.66	.51	-7.93	-0.95	.34	-2.37	-0.34	.73	-6.70	-1.00	.32	-7.03	-0.89	.37
Sugar & Starch Indicators	7.47	0.88	.38	10.80	1.09	.28	15.61	1.92	.05	2.71	0.32	.75	20.32	2.04	.04
Microscope	-4.90	-0.49	.62	-15.14	-1.58	.11	6.49	0.74	.46	-11.67	-1.33	.18	-12.11	-1.27	.20
Rock Identification	22.33	2.29	.02	11.16	0.98	.33	21.31	2.26	.02	29.55	3.26	<.01	24.11	2.44	.01
Instruments	5.25	0.72	.47	-5.44	-0.66	.51	-1.95	-0.28	.78	-0.36	-0.06	.95	-0.04	-0.00	1.00

Table 143
Texas
Science Literacy Test
Student Means
Percent Correct on Multiple Choice Items

Standard	Comparison (1995)		SS&C 1 (1996)		SS&C 2 (1997)		SS&C 3 (1998)		SS&C 4 (1999)		SS&C 5 (2000)	
	n = 216		n = 158		n = 162		n = 142		n = 55		n = 70	
	mean	s.e.	mean	s.e.	mean	s.e.	mean	s.e.	mean	s.e.	mean	s.e.
Total Score	42.22	0.73	43.85	1.04	37.08	0.80	42.54	0.94	37.55	1.39	33.22	1.19
Science as Inquiry	45.20	1.22	46.15	1.59	37.88	1.26	43.28	1.51	39.17	1.90	35.06	1.73
Physical Science	39.12	1.31	39.61	1.71	29.99	1.31	36.21	1.51	31.67	2.62	26.06	2.05
Life Science	40.20	1.07	42.04	1.46	36.47	1.28	43.13	1.43	34.55	2.11	30.05	1.77
Earth & Space Sciences	33.53	1.07	37.45	1.33	28.60	1.19	33.86	1.31	29.09	2.14	25.00	2.08
Science & Technology	47.28	1.16	46.91	1.40	48.46	1.23	47.98	1.28	49.77	2.11	43.84	1.86
Science in Personal & Social Perspectives	32.38	1.15	37.61	1.57	27.88	1.27	34.68	1.45	28.03	2.01	26.76	1.52
History & Nature of Science	58.16	1.05	57.30	1.23	52.80	1.29	59.10	1.33	53.43	2.11	48.65	1.97

Statistical Tests

Standard	1995 vs. 1996			1995 vs. 1997			1995 vs. 1998			1995 vs. 1999			1995 vs. 2000		
	Δ	z	p	Δ	z	p	Δ	z	p	Δ	z	p	Δ	z	p
Total Score	1.63	1.29	.20	-5.15	-4.75	<.01	0.31	0.26	.79	-4.68	-2.98	<.01	-9.00	-6.45	<.01
Science as Inquiry	0.94	0.47	.64	-7.32	-4.18	<.01	-1.92	-0.99	.32	-6.03	-2.67	.01	-10.14	-4.80	<.01
Physical Science	0.49	0.23	.82	-9.13	-4.94	<.01	-2.91	-1.46	.14	-7.45	-2.55	.01	-13.06	-5.38	<.01
Life Science	1.84	1.02	.31	-3.73	-2.23	.03	2.93	1.64	.10	-5.66	-2.39	.02	-10.15	-4.92	<.01
Earth & Space Sciences	3.92	2.29	.02	-4.93	-3.08	<.01	0.34	0.20	.84	-4.44	-1.85	.06	-8.53	-3.64	<.01
Science & Technology	-0.37	-0.20	.84	1.18	0.69	.49	0.70	0.40	.69	2.49	1.03	.30	-3.14	-1.57	.12
Science in Personal & Social Perspectives	4.93	2.53	.01	-4.80	-2.80	.01	2.01	1.08	.28	-4.65	-2.01	.04	-5.92	-3.10	<.01
History & Nature of Science	-0.85	-0.53	.60	-5.35	-3.22	<.01	0.95	0.56	.58	-4.73	-2.01	.04	-9.51	-4.26	<.01

Table 144
Texas
Hands-On Full Investigation
Student Means
Percent Correct by Total Score and Subscores

	Comparison (1995)		SS&C 1 (1996)		SS&C 2 (1997)		SS&C 3 (1998)		SS&C 4 (1999)		SS&C 5 (2000)	
	n = 6		n = 5		n = 6		n = 7		n = 8		n = 5	
	mean	s.e.	mean	s.e.	mean	s.e.	mean	s.e.	mean	s.e.	mean	s.e.
Total Score	53.11	10.81	61.73	1.85	61.17	9.52	62.62	7.52	73.13	6.02	72.40	6.22
Number of Conditions	60.00	17.13	72.00	12.00	60.00	13.66	71.43	14.38	75.00	9.82	72.00	12.00
Access to Conditions	37.50	8.54	55.00	5.00	37.50	12.50	46.43	12.71	68.75	12.27	60.00	6.12
Amount of Conditions	54.17	20.83	55.00	14.58	66.67	21.08	64.29	17.13	65.63	11.51	90.00	10.00
Method of Measurement	58.33	8.33	60.00	10.00	58.33	8.33	50.00	10.91	81.25	13.15	60.00	10.00
Number of Bugs	55.56	16.48	66.67	10.54	83.33	7.45	80.95	6.73	75.00	8.33	80.00	8.16

Statistical Tests

	1995 vs. 1996			1995 vs. 1997			1995 vs. 1998			1995 vs. 1999			1995 vs. 2000		
	Δ	z	p	Δ	z	p	Δ	z	p	Δ	z	p	Δ	z	p
Total Score	8.62	0.79	.43	8.06	0.56	.58	9.51	0.72	.47	20.01	1.62	.11	19.29	1.55	.12
Number of Conditions	12.00	0.57	.57	0.00	0.00	1.00	11.43	0.51	.61	15.00	0.76	.45	12.00	0.57	.57
Access to Conditions	17.50	1.77	.08	0.00	0.00	1.00	8.93	0.58	.56	31.25	2.09	.04	22.50	2.14	.03
Amount of Conditions	0.83	0.03	.98	12.50	0.42	.67	10.12	0.38	.70	11.46	0.48	.63	35.83	1.55	.12
Method of Measurement	1.67	0.13	.90	0.00	0.00	1.00	-8.33	-0.61	.54	22.92	1.47	.14	1.67	0.13	.90
Number of Bugs	11.11	0.57	.57	27.78	1.54	.12	25.40	1.43	.15	19.44	1.05	.29	24.44	1.33	.18

Table 145
Texas
Written Full Investigation
Student Means
Percent Correct by Total Score and Subscores

	Comparison (1995)		SS&C 1 (1996)		SS&C 2 (1997)		SS&C 3 (1998)		SS&C 4 (1999)		SS&C 5 (2000)	
	n = 2		n = 5		n = 4		n = 7		n = 5		n = 3	
	mean	s.e.	mean	s.e.	mean	s.e.	mean	s.e.	mean	s.e.	mean	s.e.
Total Score	36.67	36.67	12.80	7.14	70.42	10.61	37.95	7.95	5.80	5.80	2.22	2.22
Number of Conditions	50.00	50.00	4.00	4.00	75.00	9.57	45.71	16.16	4.00	4.00	0.00	0.00
Access to Conditions	0.00	0.00	10.00	10.00	62.50	12.50	32.14	8.99	5.00	5.00	0.00	0.00
Amount of Conditions	50.00	50.00	0.00	0.00	93.75	6.25	35.71	15.29	0.00	0.00	0.00	0.00
Method of Measurement	50.00	50.00	30.00	20.00	37.50	23.94	42.86	13.04	0.00	0.00	0.00	0.00
Number of Bugs	33.33	33.33	20.00	13.33	83.33	9.62	33.33	10.29	20.00	20.00	11.11	11.11

Statistical Tests

	1995 vs. 1996			1995 vs. 1997			1995 vs. 1998			1995 vs. 1999			1995 vs. 2000		
	Δ	z	p	Δ	z	p	Δ	z	p	Δ	z	p	Δ	z	p
Total Score	-23.87	-0.64	.52	33.75	0.88	.38	1.29	0.03	.98	-30.87	-0.83	.41	-34.45	-0.94	.35
Number of Conditions	-46.00	-0.92	.36	25.00	0.49	.62	-4.29	-0.08	.94	-46.00	-0.92	.36	-50.00	-1.00	.32
Access to Conditions	10.00	1.00	.32	62.50	5.00	<.01	32.14	3.58	<.01	5.00	1.00	.32	0.00	0.00	<.01
Amount of Conditions	-50.00	-1.00	.32	43.75	0.87	.38	-14.29	-0.27	.79	-50.00	-1.00	.32	-50.00	-1.00	.32
Method of Measurement	-20.00	-0.37	.71	-12.50	-0.23	.82	-7.14	-0.14	.89	-50.00	-1.00	.32	-50.00	-1.00	.32
Number of Bugs	-13.33	-0.37	.71	50.00	1.44	.15	0.00	0.00	1.00	-13.33	-0.34	.73	-22.22	-0.63	.53

Table 146
Student Outcome Effect Sizes

	California					Iowa					Montana				
	95-96	95-97	95-98	95-99	95-00	95-96	95-97	95-98	95-99	95-00	95-96	95-97	95-98	95-99	95-00
Inclination/Motivation/Attitudes	-0.27	-0.38	-0.41	-0.27	-0.39	-0.10	1.26	1.22	1.20	1.32	0.32	0.53	0.43	0.08	0.20
Lab Skills Performance Test	-0.35	-0.64	-0.17	-0.40	-0.37	0.37	0.18	0.46	0.46	1.10	0.56	0.89	0.42	0.56	0.62
Hands-On Full Investigation	0.54	1.62	-0.19	0.40	-0.25	0.03	0.53	0.78	0.01	0.81	1.08	0.32	1.23	0.87	1.24
Written Full Investigation	-1.66	-1.11	-3.60	-2.28	-1.00	0.16	-0.13	0.42	0.22	-0.13	0.71	0.74	0.82	-0.10	1.10
Science Literacy Open-Ended Questions	0.21	0.19	0.75	0.07	-0.14	-0.52	0.11	-0.12	-0.30	-0.34	0.14	0.27	-0.45	0.04	-0.45
Science Literacy Multiple Choice Items	0.23	0.21	0.20	0.04	0.18	-0.57	-0.39	-0.49	-0.58	-0.59	-0.03	-0.07	0.03	0.01	0.01

	New York					Texas				
	95-96	95-97	95-98	95-99	95-00	95-96	95-97	95-98	95-99	95-00
Inclination/Motivation/Attitudes	1.41	-0.06	0.13	-0.60	-1.53	0.92	0.72	0.60	0.32	0.27
Lab Skills Performance Test	0.97	1.19	1.06	0.19	1.09	0.81	0.15	0.62	0.48	0.63
Hands-On Full Investigation	0.04	0.58	0.45	1.54	2.40	0.43	0.32	0.41	0.93	0.88
Written Full Investigation	1.39	2.13	0.88	-0.84	*	-0.88	1.06	0.05	-1.19	-1.14
Science Literacy Open-Ended Questions	0.59	1.30	0.68	0.07	0.67	0.06	-0.26	0.18	-0.73	-0.66
Science Literacy Multiple Choice Items	0.46	0.24	0.46	0.22	0.07	0.14	-0.49	0.03	-0.44	-0.85

* Data not available

Effect sizes for inclination, motivation, attitude, and all achievement measures were reported for each state on charts and in a table in the Appendix. Effect size (d) is a measure of the degree to which two means differ in terms of the standard deviation of the parent population. In this study, the scores on all of the measures administered in the years after the reform was implemented (1996, 1997, 1998, 1999, 2000) were contrasted with the scores on the measures in the comparison year (1995). Because of the large differences between the years, the standard deviation was calculated for each pair ofyears separately. The measure of standard deviation used was the " square root of the pooled variance" for the two years being compared for each instrument. T his procedure best controlled for statistical bias and error. The formula used was: d=Mean1-Mean2/square root of pooled variance$_{\text{within group}}$. The effect size chart allows us to consider relative educational significance in addition to statistical significance. For the purposes of this report, an effect size of ± 0.5 was considered to be educationally significant.

Appendix B
Instrument Descriptions

INTRODUCTION

This appendix describes the development, characteristics and analyses of the instruments used in the summative evaluation of the SS&C project. The SS&C project is a teacher enhancement process and set of materials for science education in grades 9-12, but the SS&C project and this evaluation were funded by the National Science Foundation for only the ninth grade portion. The SS&C project was committed to developing activities that produced students that were better prepared according to the National Research Council's Science Education Standards. As a result, these content and teaching standards served as the guidelines for the development of the assessment instruments used in this evaluation (National Research Council, 1995). This means that the SS&C project was evaluated on how well the curriculum prepared students based on the standards not on the specific goals or objectives of SS&C. The seven science education content standards have specific goals and objectives for the various grade levels: K-4, 5-8 and 9-12. The content standards are: science as inquiry, life science, physical science, earth and space science, science and technology, science in social and personal perspectives and history and nature of science.

The evaluation gathered data about students, teachers and schools at thirteen sites nationally over a three-year time frame and then followed on with five sites for another three years. During the first year of the evaluation effort data were collected from students similar to those who would be receiving the SS&C curriculum during the second year. During the subsequent years data were collected from SS&C students at the same schools where data were collected during the first year. Evaluation team members visited all sites in the fall and spring of all but one year when only a spring visit was made. Ten instruments were developed to assess student understanding of the content standards, student attitudes and motivation and the classroom environment in which these understandings were developed: a classroom observation schedule, principal, teacher and student interview protocols, a teacher questionnaire, a course content survey, a student questionnaire, a student hands-on full investigation test, a student laboratory performance test, and a student science literacy test. In addition to using these instruments to assess the project, a case study of three teachers involved in the implementation was also conducted.

The primary goal of the evaluation was to assess understanding of the content standards, therefore achievement was assessed in a variety of ways to help ensure validity of the findings. The students completed traditional multiple choice items, open-ended items, a series of hands-on laboratory stations, a hands-on full investigation and a written full investigation. Members of the evaluation team administered all of the assessment devices during site visits except the science literacy tests, which included the multiple choice and open-ended items. The literacy tests were mailed out to the sites for the teachers to administer. To maintain confidentiality the tests were counted into classroom sets with class lists before mailing. Teachers were asked to not make copies of the tests and to return all used and unused copies. Standardized administration protocols were developed and read to the students at the beginning of each testing situation to insure consistency of administration.

Individual descriptions of each instrument follow. The student outcome measure instruments will be described first, followed by descriptions of those instruments designed to provide descriptive and environmental information.

STUDENT OUTCOME MEASURES

Science Literacy Test

The purpose of the science literacy test was to assess comparison and SS&C student understanding of the seven NRC science content standards. It was critical that this test contained science items deemed appropriate by a national audience so the items for the science literacy test were selected from existing tests such as NAEP, SISS, and IAEP. The items for those tests had been developed through a rigorous consensus and review process and thus represented a national perspective on appropriateness. Additionally the national data available for some of the items could be used as a comparison for the results from this evaluation. A team of science educators went through all of the available items independently and rated them on their relevancy to the new NRC standards and their appropriateness for ninth graders. The independent ratings were combined and the team discussed any controversial items to determine the value of including them. Care was taken to select both open-ended and multiple choice questions and to not overlap on content. Outside science education experts reviewed all of the items in the final selection to confirm that the items were, indeed, consistent with the NRC standards. A draft version of the Science Literacy Test was pilot tested locally with 9th grade students at both a suburban and an urban school to assess the length, difficulty and readability of the test.

Twenty-six items were selected for each of the seven NRC science content standards, except for the technology standard which had only 16 items because additional national assessment items that matched the standard could not be located. Of the 172 items administered to students, 12 were open-ended and 160 were multiple-choice. Approximately 40% of the items were higher level reasoning items requiring at least application level understanding as defined by Bloom (1956) and Madaus (1989). This was determined by having two independent raters rate each of the items after receiving training and becoming reliable raters on the Madaus definition. The items were used to construct two parallel forms of the science literacy test. Half of the students in each class took form A of the test while the other half took form B. Their teachers administered the test to students over two 45-minute class sessions near the end of the school year.

Multiple-choice items on the science literacy test were scored as either correct or incorrect. All collected data were scored. Initially, standard errors were estimated using the bootstrap method because two parallel forms of the science literacy test were administered to students, (Efron & Tibshirani, 1993). The bootstrap method estimates the overall standard error of both forms of the test by taking the average of 200 randomly sampled standard errors. However, subsequent comparisons of the standard errors calculated using DESCRIPTIVES on SPSS showed that the calculated value of the standard error using ordinary methods falls in the middle of the distribution of a sample of 100 bootstrap estimates of the standard error. This result is consistent with the findings of other studies examining the utility of bootstrapping (Welch, Lawrenz, & Huffman, 1998) and has the additional advantage of remaining constant across multiple calculations, unlike the bootstrap estimates. Comparisons between years were made on the total score of all multiple-choice items and on the multiple-choice items for each of the seven content standards. Comparisons were calculated using *z*-scores. Charts were created to show changes over time on total score and effect size across sites and by site. Detailed tables support the data in the charts and present the statistical test data. Tables also include scores by site for each of the seven NRC Science Standards along with the total score. In the first SS&C year, the Cronbach alpha reliability for the multiple choice items was .89 for form A and .88 for form B. The reliabilities for each scale, for forms A and B of the multiple choice science literacy items respectively, were science as inquiry (.59 and .62), physical science (.66 and .67), life science (.64 and .62), earth and space science (.53 and .56), science and technology (.13 and .06), science in personal and social perspectives (.71 and .68), and history and nature of science (.48 and .38).

The 12 open-ended items on the science literacy test were scored for all classes and all students in 1995. Subsequently, only those classes that were selected for observations at each site had their open-ended items scored. The open-ended questions were also selected from the previously mentioned existing national tests to match the NRC standards. The items were included on the same test forms as the multiple-choice items and, therefore, the numbers of students and administration procedures were the same. The items were split across the two forms of the test so each student only answered six items. The Cronbach alpha reliability of Form A was .67 and for Form B was .69. The evaluation team developed a coding scheme for the items based on the recommended scoring rubrics and the uniqueness of these students' responses. Team members individually scored some of the tests and then the team discussed their coding to verify interpretations. This coding was then applied to the full set of tests. For final scoring the codes were collapsed into categories of completely correct (2 points), partially correct (1 point), or incorrect (0 points). The maximum possible on the open-ended items was 12 points, and the percent correct was calculated by dividing the actual umber of points received by 12 and multiplying by 100. Four members of the evaluation team scored the complete set of items; two members scored the items from the comparison year and two different members scored the items from the first SS&C year. Intra-rater and inter-rater reliabilities for the comparison year were assessed based on a random sample of 20 form A tests and 20 form B tests. For the comparison year the average intra-rater reliability for the two scorers was 93%, and the inter-rater reliability was 95%. The same procedure was used to calculate reliabilities for the two scorers in the first SS&C year. For the first SS&C year the average intra-rater reliability was 93%, and the inter-rater reliability was 91%. The average inter-rater reliability between the comparison and each SS&C year was assessed by having the SS&C year scorers rescore a random sample of 20 tests of form A and 20 tests of form B from the comparison year. For the second through fifth SS&C years, respectively, the average intra-rater reliabilities were 93%, 94%, 94%, and 97%. The average inter-rater reliabilities between the comparison and each SS&C year were 88%, 92%, 93%, and 96% for the second, third, fourth, and fifth SS&C years, respectively.

Comparisons using z-statistics and effect size calculations were conducted for each year in contrast to the comparison year. These data are presented in cross site and by site tables. Both mean scores and effect sizes over the years are also presented in charts in the body of the report in both the cross site and by site sections.

Lab Skills PerformanceTest

The purpose of the hands-on lab skills test was to determine if there were any differences in the laboratory skills of the comparison and SS&C year students. As with the science literacy test, in order to assure national acceptance of the items used, the instrument was developed from already existing and validated items. Each station was selected from existing national performance tests including the NAEP, SISS, and the International Assessment of Educational Progress, the Assessment of Performance Unit (APU, 1981) (Welford, Harlen, Schofield, 1985) and the British Columbia Science Performance Test (Bartley, Carlisle & Erickson, 1993). The five stations included determining density, chemical testing of starch and sugar solutions, using a microscope, testing and identifying rocks, and using measuring instruments. The density station asked students to use lab equipment to find the mass, volume, and density of a sinker. The indicators station asked students to conduct a test using indicators to determine which solutions contained sugar, starch, and neither sugar nor starch. The microscope station asked students to draw what was a slide at 10X and higher magnifications and then to determine which threads were on top of others on a second slide using the microscope. The rocks station asked students to identify three rocks using physical properties and simple chemical tests. The instruments station asked students to conduct laboratory measurements (volume, temperature, length, mass) using lab equipment. A draft version of the lab skills performance test and the full investigation described below were pilot tested locally with 9th grade students at both a suburban and an urban school to assess the length and difficulty of the items, along with appropriateness of equipment and presentation.

Members of the evaluation team administered the stations during the spring site visits and all of the equipment except for triple beam balances and microscopes were provided by the evaluation team to insure consistency of the test administration. Because of the time needed to administer the practical tests, only random sets of students at each of the thirteen school sites were selected to answer these questions. At each school site, the students who took the lab skills performance test were randomly selected from the three classes that were observed resulting in approximately 80-120 students completing the test each year. Students who did not take the lab skills performance test were asked to complete the student questionnaire described below. The lab stations were set up in a classroom and the selected students rotated through the stations spending seven minutes working on each one.

Each of the five stations was scored using the scoring scheme devised by the developers of that test. These "raw" scores were then rescaled so that each variable used the same scale and thus contributed equally to the calculation of each station score and the total score. For example, the variable MVALUE (Mass Value) was originally scored on a 4-point scale (4 = Completely correct, 0 = Completely incorrect). It was converted to a five-point scale with the command:

compute MVAL = ((MVALUE/4) * 5)

This was done for each variable, and the variables were summed to get a station score using the SUM function in SPSS. Each variable was then divided by 5 and multiplied by 100 to get a percent score. The total score for each station was also changed to a percent score. Finally, the station totals were added up, divided by the total number of rescaled points (165) and multiplied by 100 to get the overall percent score for the test. These percent scores for the stations and the overall test, with accompanying standard errors, are the primary numbers used in reporting this data. The total lab skill scores and the scores for each of the stations for each year of this study were compared to the scores in the comparison year using z-statistics. The scores and statistical tests for total score are presented in the cross site Tables and scores and statistical tests for total score and each station are presented in the by site Tables. Charts showing the changes in total score and effect sizes over time are presented in the body of the report in both the by site and cross site sections.

The intra-rater reliability of the scoring was assessed by re-scoring a random sample of 20 tests for each year. The 20 tests from the comparison year were also scored by another member of the research team to assess inter-rater reliability. The mean intra-rater reliability over both the comparison and first SS&C year was 93%, and the inter-rater reliability for the comparison year was 91%. The mean inter-rater reliabilities for the SS&C years ranged from 88% to 97%. The mean intra-rater reliabilities for the second through fifth SS&C years ranged from 91%-97%. Cronbach alpha reliability for the lab skills test in the first SS&C year was 84%. The reliabilities for each station were .85 for density, .90 for sugar and starch indicators, .67 for microscope, .85 for rock identification, and .48 for instruments.

Full Investigation Test

The purpose of the full investigation was to demonstrate student ability to design an experiment as proposed in the NRC inquiry standard. The hands-on version then asked the student to conduct the experiment and record the results. Both the written and hands-on full investigation tests were based on the classic "bugs test" developed by the Assessment of Performance Unit in the United Kingdom (APU, 1981). The test asked students to design an experiment to determine which of the following environments isopods prefer: light and dry, light and wet, dark and dry, or dark and wet. A member of the evaluation team scored both the hands-on and written versions of the test. Inter-rater and intra-rater reliability of the scoring of the hands-on full investigation test was checked by re-scoring a random sample of 20 tests from both the comparison year and the first SS&C year. For the comparison year the inter-rater reliability was 85%, and the average intra-rater reliability was 91%. For the first SS&C year the Cronbach alpha reliability for the hands-on full investigation test was .75. Inter-rater and intra-rater reliability of the scoring of the written full investigation test was checked by re-scoring a random sample of 20 written tests from both the comparison year and the SS&C year. For the comparison year, the inter-rater reliability was 85%, and the average intra-rater reliability was 92%. The individual who received this 92% intra-rater reliability subsequently scored both the written and hands-on full investigations for the six years of the project. The Cronbach alpha reliability for the written full investigation test in the first SS&C year was .88.

Each year two students were randomly selected to complete this assessment from each of the three classes observed at each site. The students were given the necessary experimental apparatus and asked to draw their experimental set-up, describe it in writing and state their conclusions. Isopods, and various types of equipment like timers, sponges, black paper, containers, etc. were provided. A written version of this test (see the description of the student questionnaire below) was administered to students who did not take the hands-on test. The written version was identical to the hands-on test, except students did not have materials and were instead asked to imagine and describe how they would perform the experiment.

The hands-on and written versions of the experimental design tests were scored in an identical manner using the APU scoring rubric that focused on aspects of the design and implementation of experiments. Five aspects of conducting an experiment were scored: 1) the number of environmental conditions presented to the isopods, 2) the extent to which access to different conditions was controlled, 3) the extent to which the amount (i.e. the area or volume) of each environmental condition was controlled, 4) the primary method of measurement, and 5) the number of isopods used to conduct the experiment. Each of the five parts of the score were equally weighted and placed on a scale from 0 to 10. This was accomplished by using COMPUTE on SPSS as follows:

```
COMPUTE NumberP = (Number/5)*10.
```

A total score was calculated by adding the five parts of the score thus creating a score that ranged from 0 to 50. The percent correct for each subscore was calculated by dividing the weighted score, as calculated above, by 10 and multiplying by 100. The overall percent correct was obtained by dividing the total by 50 and multiplying by 100. The percent correct for each scoring category and the total score are included in the by site Tables along with *z*-tests results comparing the scores to the comparison year. Charts were created to show change over time on hands-on and written full investigation total scores and effect sizes across sites and by site.

Student Questionnaire

The purpose of the student questionnaire was to assess both students' perceptions of the learning environment as described in the NRC standards and students' attitudes and motivation. The questionnaire was 12 pages long and took about 30 minutes to complete. All of the appropriate ninth graders at each site except those selected for the hands-on testing completed the questionnaire. Responses to the items were directly inputted from the questionnaire and average ratings were calculated and compared to the comparison year using *z*-tests.

The bulk of the questionnaire was a six-scale learning environment inventory containing 37 items. The 5-point Likert scale items measured six aspects of the learning environment: 1) involvement (6 items), 2) difficulty (6 items), 3) relevancy (7 items), 4) critical voice (7 items), 5) experimental design (5 items), and 6) sequence (4 items). The involvement scale assessed students' perceived personal involvement in the classroom. The difficulty scale measured the students' perception of the academic difficulty in their classroom. The relevancy scale concerned the perceived relevance of school science to students' out-of-school experiences. The critical voice scale assessed the extent to which students believe it is acceptable and beneficial to question a teacher's pedagogical plans and methods (Taylor, Fraser & White, 1994). The experimental design scale examined the students' perception of the degree of open-endedness in the design of the experiments that were conducted in the classroom. The sequence scale measured the perceived sequence of classroom instruction, for example, whether or not the teacher used hands-on activities before lecturing to the class. All items were written in the personal form as recommended by Fraser and Tobin (1991), in order to more accurately elicit students' perceptions of the classroom learning environment. The personal relevance and critical voice scales were taken intact from Taylor, Fraser and White's (1994) Constructivist Learning Environment Scale. The other four scales, experiment design, student involvement, sequence and difficulty, and were developed by the evaluation team. The development consisted of selection, modification or invention of items based on other environment inventories. This was followed by a series of two field tests with samples of both urban and suburban 9th graders, reliability estimations and factor analyses. Based upon the results of the reliability analysis and the factor analysis, modifications were made to the items and the new items were field tested again with another sample of students. All items were also checked for readability and interpretation before field-testing. The Cronbach alpha reliability for each scale on the learning environment instrument in the first SS&C year was as follows: involvement, .70; difficulty, .79; relevancy, .76; critical voice, .80; experimental design, .55 and sequence, .61.

In addition to the learning environment items, the student questionnaire also requested demographic information, contained 24 items related to students' attitudes toward science, and contained the written version of the full investigation test. In the attitude section students were asked what science activities they engaged in outside of school (10 Yes/No items), what science courses they planned to take in the future, if they are motivated by science and their experiences in their science class (8 Yes/No items) and their perceptions of the class as fun, interesting, relevant, etc. (6 Likert items).

The variables in the LEI-Student Questionnaire are laid out in a relatively straightforward manner, but breakdown of the variables is somewhat complex. A variety of different types of items are being used and each type has a slightly different procedure for analysis.

The first 37 items of the questionnaire comprise the Learning Environment Inventory. The subscales of the LEI are computed using the MEAN procedure in the SPSS control file and include Difficulty, Relevance, Critical Voice, Involvement, Sequencing, and Experimenting. The means and standard errors of these subscales are reported along with the results of t-tests comparing the scores to the comparison year are presented in the by site Tables, and charts showing change over the years are in the by site section of the report.

The next set of variables includes items that ask about science activities in which the students participate outside of class. These 10 variables have been recoded so that 100 = Yes and 0 = No. Thus, these variables are reported as the percentage of students who indicated that they participated in each activity. These data and the results of z-tests comparing the later years of the comparison year are presented in the by site Tables.

A similar recoding procedure was used on q52a to q56, the eight variables that addressed the student's intention to continue taking science classes and science motivation. The analysis of these variables represents the percent of students responding "Yes" to each item. These data and the results of the z-tests comparing the later years to the comparison year are presented in the by site Tables. Subsequent analyses are described below.

Items 57 to 62 ask questions about the student's attitudes about science. These six items were initially reported individually on the 5-point Likert scale. This means, standard errors and t-tests comparing the later years to the comparison year are presented in the by site Tables, and the mean responses for each item are presented in the by site charts.

The last two years of the project, the attitude variables were also recoded into a yes/no format and combined with the items addressing inclination to continue studying science (with the exception of q52a, Do you plan to take science in 10th grade?, because all students in the sample were required by law to take science in 10th grade so there was no variability on that item) and science motivation, in a single Inclination, Motivation, and Attitudes scale. Responses indicating disagreement with the attitude items (i.e. a 1 or a 2) were recoded as No = 0 and responses indicating agreement (i.e. a 4 or a 5) were recoded as a Yes = 100. Responses that indicated no opinion on the attitude items (i.e. a 3) were coded as system missing. Since this resulted in a sizable number of missing variables, the new scale was calculated "by hand", not by using MEAN in SPSS. The formula was as follows: (q52b+ q52c+ q52d+ q53+ q54+ q55+ q56+ newq57+ newq58+newq59+newq60+newq61+newq62)/13. The results of this combined score and z-tests comparing the later years to the comparison year are presented in the cross site Tables. The scores over the years are displayed in charts in the body of the report in the cross site and by site sections.

Items 63 to 72 inquired about the kinds and frequency of various activities in class. These items asked students to estimate the frequency of various teaching techniques in their science classrooms. For the first four years of the project these variables were reported just as they were, calculating the mean response for each item. The last two years, these items were factor-analyzed and regrouped based on the results of that analysis. The data about individual items included in this report were those items included in one of the new groups. The final regrouping of the items is as follows:

New grouping	Items included
Inquiry	q74 - Demonstration of a scientific principle q76 - Ask students to suggest hypotheses q77 - Ask students to interpret data q78 - Relate current topic to previous work
Groups	q63 - Do experiments with other students q69 - Work in groups q71 - Share experiment results
Traditional	q65 - Read articles about science q66 - Do an oral or written report q67 - Read other materials
Other	q68 - Watch films, slides, or videos q70 - Go outside for class instruction

The above scales were calculated using MEAN on SPSS. The results of this recombination were reported in two ways: as the mean score of the scale on the original 5-point Likert scale and as the percent of time spent in each category. To obtain this number, the four scales were added together to obtain a "total score" of sorts. Then, each category score was divided by this new total and multiplied by 100 to obtain an estimate of the percent of time spent in each type of activity. The mean and standard error and t-test comparisons for the later years with the comparison year for the totals and by items are presented in the by site Tables. The total scores and statistical tests for frequency and percent time are also presented in the cross site Tables. Charts for percent time over the years are in the by site section of the report.

The last two pages of the instrument are the written form of the Full Investigation and are coded separately from the rest of the questionnaire. See the section describing the Full Investigation for further details.

DESCRIPTIVE MEASURES

Classroom Observations

Classroom observations were conducted to verify implementation of the SS&C curriculum and to document the behaviors in an actual classroom setting. In the comparison and the SS&C years each site was visited twice, once in the fall and again in the spring. The only exception to this occurred during the 1997-98 school year. No site visits were made in the fall of 1997 due to funding constraints. During each visit three classes, taught by three different teachers if possible, were observed. Classroom observations typically lasted for 45-50 minutes, depending upon the length of the class period. Given the limited number of classroom observations, these were viewed as supporting documentation, rather than as a primary data source.

The classroom observation form was developed from the descriptions of ideal science classrooms in the standards. The observation schedule was two pages long and had forty different items documenting several aspects of the learning environment including the following information: student involvement, student and teacher questioning behavior, teacher rapport, cooperative group work as defined by Johnson and Johnson (1991), type of laboratory work as based on Schwab's levels of involvement, relevancy of content to the "real world", and critical voice of the students (i.e., the extent to which students believe it is acceptable and beneficial to question the teacher's methods and knowledge claims). The form also included items describing the setting and the equipment available. Throughout each observation period, the observers documented the most common form(s) of instruction that occurred during every 5-minute interval. In order to ensure consistency of use of the instrument, all of the evaluation team observed several classes locally using the schedule before it was finalized to achieve consensus of opinion on categorizations. As a final check after the first use of the schedule at the sites, the evaluation team members discussed what had been observed and decided how to best represent that on the schedule. As an additional attempt at consistency, the same observers conducted the site visits all years whenever possible.

The observation data regarding the specific activities or teaching strategies being used in the class during each five-minute interval was coded into categories. For the data collected from Fall 1994 to Spring 1997, these categories included Lecture, Small Group Discussion, Demonstration, Lecture with Discussion, Administrative Tasks, Cooperative

Learning, Class Discussion, Text Seat Work, Teacher Interacting with Students, Hands-on Activity/Materials, Worksheet Work, and Other. Data from Spring 1998 onwards included two additional categories: Reading Seat Work and Lab Write-up.

The SPSS control file read these data as both a six-digit code per interval and as three separate two-digit codes. That is, in the SPSS data list file used to create the working system file, the following code would have appeared to describe the data collected in the first five-minute observation period: OBS10 25-30, OBS10A 25-26, OBS10B 27-28, OBS10C 29-30. Rather than focus on the individual codes, it was decided that the six-digit codes would be collapsed into five broad categories of class activities. Each six-digit code was assigned to only one category. The original data were therefore recoded as follows:

Lecture, Worksheet Work, Text Seat Work and Reading Seat Work alone, in combination or with other codes	Teacher-Centered
Lecture with Discussion, Class Discussion, Demonstration alone, in combination or with other codes	Both Teacher- and Student-Centered
Hands-on Activities/Materials, Small Group Discussion, Lab Write-up alone, in combination or with other codes	Student-Centered
Administrative alone or with other codes	Administrative
Other activities	Other

The recoding process took several steps. The first step was to list the possible values for each six-digit code. Then, the codes were reviewed and were assigned by hand to one of the five categories. For example, if the six-digit code was 041102 (Hands-on Activity, Teacher Interacting with Students, and Lecture with Discussion) the variable was recoded as 2, Both Teacher and Student-Centered. In SPSS, this recoding resulted in the creation of the variables "newobs10…newobs21". Then, using COUNT in SPSS, the five categories were created as follows:

```
COUNT TeaCen = Newobs10 thru NewObs21(1).
COUNT STCen = Newobs10 thru NewObs21(2).
COUNT StuCen = Newobs10 thru NewObs21(3).
COUNT Admin = Newobs10 thru NewObs21(4).
COUNT Other = Newobs10 thru NewObs21(5).
```

Finally, the DESCRIPTIVES command with the SUM subcommand was used to get the total number of responses that fall into each category. The percentages of responses in each category were calculated by hand, as were the chi-square tests comparing each SS&C year to the comparison year. These data are presented in the by site Tables and charts are included in the by site section of the report.

In the final year of the project, these data were also reported as a continuous variable showing the percent of time spent in Teacher-Centered, Both Teacher- and Student-Centered and Student-Centered activities. This was done by summing the totals of all five categories to obtain an overall "total score" of sorts then dividing the totals for each of the three categories mentioned above (Teacher-Centered, Both Teacher- and Student-Centered, and Student-Centered) by this overall total and multiplying by 100. The MEAN procedure in SPSS was then used to calculate the average percent of time spent in each category for each site. These data are presented in charts in the cross site section of the report and are included in the cross site Tables.

The rest of the data addressing the classroom environment, the ratings of teacher rapport, student involvement, critical voice, level of open-endedness, relevancy, and type and number of teacher and student questions, is largely categorical data of the "Always, Sometimes, Never" or "Yes, No" variety. It was summarized using CROSSTABS and the chi-square test was used to compare data across years. Only data on observation ratings of the level of student involvement and type of instruction were included in this report. These data are presented in the by site Tables and discussed in the text.

Principal, Teacher and Student Interviews

The interviews were designed to corroborate data from the other instruments and to allow participants the opportunity to describe things in their own way. Interviews were conducted one-on-one with members of the evaluation team during the site visits. Interview questions were matched to questions asked of the students on other instruments and those used on the observation schedule to facilitate cross verification. The principals were interviewed once in the fall. The teachers were interviewed in both the spring and the fall. The three teachers at each site whose classes had been selected for observation were interviewed using the long form while other ninth grade teachers were interviewed using the short form. After the third year of the project the teacher interview forms were changed to reflect the new longitudinal perspective of the evaluation. One student in each of the observed classes was interviewed during the spring site visit.

The school principal interview was designed to obtain a general description of the school and community, and to elicit the principal's perceptions of the stability of their school populations as a check on the validity of between-year comparisons. The protocol was about one page long, included 20 questions and took approximately 15 minutes to administer. Data from four items addressing sources of potential problems are the only items for which there is numerical data.

Student interviews were conducted to verify student perception of the learning environment in the course they were taking and their attitudes toward science. The interview protocol was two pages long, included fourteen questions and took approximately 15 minutes to administer. Responses to the eight items which produced numerical data included both Yes/No responses and A lot/Some/Never responses.

Teacher interviews were designed to obtain teachers' perceptions of their classroom activities and the learning environment in their classrooms. From Fall 1994 to Spring 1998, two versions of the interview form were used. The long form interview was administered to the three observed teachers at each site, and the short form was used for any additional teachers. The long form asked questions specifically about the class that had been observed as well as questions about the teachers' approaches to teaching science. The long form was three pages long, contained 17 different questions and took about 30 minutes to administer. The short form was identical to the long form except that ten of the more specific questions were removed.

In the 1998, 1999 and 2000 school years, a different version of the interview form was used. Teachers were asked about the support for their courses, the vision the teacher had for science education, and how decisions got made at their schools. In addition, teachers were asked to estimate the percent of lab activities that fall into one of four categories that varied in the relative amounts of student and teacher control, to describe general patterns they remembered from each year of the project, and to rate how well the teacher's classes were aligned with the science content standards. No data from the interviews are presented in the Tables or charts. The data were used to inform the qualitative impressions.

Teacher Questionnaire

The teacher questionnaire requested demographic information, teachers' ratings of how often they used various instructional techniques, and teachers' perceptions of the learning environment of their classrooms. From 1995 to 1997, the questionnaire was four pages and had 34 five option Likert scale rating questions addressing instructional techniques and learning environment, and 13 additional items which teachers used to indicate the amount of emphasis they placed on various topics throughout the year. The items that asked teachers to indicate how often particular instructional techniques occur were matched to similar items on the Student Questionnaire and the classroom observations. Here, as on the Student Questionnaire, the instructional techniques were factor analyzed and the results were used to regroup these items into two new variables. The resulting groups are listed below:

New grouping	Items included
Inquiry	q1 - Do experiments with other students q16 - Ask for reasons for results of experiments q17 - Ask students to suggest hypotheses q18 - Ask students to interpret data
Traditional	q3 - Read articles on science q4 - Do an oral or written report q5 - Use supplementary science materials for reading

These are the categories used to report the data in the 1995-2000 report, using the MEAN function on SPSS to calculate the variables. The results of this recombination were reported as the mean score of the scale on the original five point Likert scale for each variable. Measures and standard errors for the total scores and each item along with t-tests comparing the later years to the comparison year are presented in the by site Tables. Total scores are presented in the by site charts.

In addition to these preceding items, from Spring 1998 onward, the questionnaire also included items that asked the teachers to estimate the percent of time they spend in various kinds of class activities. It also asked teachers to estimate the amount of time they spent on specific individual, group, and whole class activities. Individual activities included hands-on activities, lab write ups, textbook and other reading seat work, worksheet work, journaling, computer work and other. The group activities included hands-on activity, small group discussion, lab write ups, worksheet work and other. Whole class activities included lecture, class discussion and demonstrations These data were summarized and mean scores and standard errors are presented for the three years in the by site Tables.

Course Content Survey

The course content survey was used to document the topics taught during the comparison and SS&C years. One teacher at each school was asked to list the topics they taught in their science classes and to estimate the number of weeks spent on each topic. In addition, teachers were asked to examine a list of twenty-eight topics from the NRC standards and estimate the number of weeks spent on each topic. The survey was three pages long and was mailed out for the teachers to complete with the literacy tests near the end of the school year. The first section of the survey was analyzed by assigning each topic listed by the teacher to one of seven categories, Chemistry, Biology, Earth and Space Science, Physics, Measurement, Science and Society, and Miscellaneous. The numbers of weeks spent on each topic indicated were then summed up for each category. The data for this part of the survey was then reported as the number of weeks spent on each category at each site. The number of weeks and percent of total class time are presented in the by site Tables.

The second part of the course content survey was analyzed by grouping the 28 topics listed into seven categories according the NRC standards: physics, life science, earth and space science, science and technology, science in personal and social perspectives, inquiry, and the history and nature of science.

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